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† In marine separate.

CORRECTIONS

REVIEW, May, 1925:

On page 207, second column, the equation below Table 3 should read:

$$r^1 = \left(\int r.dT \right) : 9.9$$

INDEX for 1924:

Page iii, 2d item under January, after "8 a. m.", insert "for April".

REVIEW, June, 1925:

Page 248, in Table 1, the minimum temperature on April 23 and 24 should be 53 and 62, respectively.

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AN ANALYSIS OF SOME FREE-AIR OBSERVATIONS IN THEIR RELATION TO PRECIPITATION

By V. E. JAKL

In a previous paper by the writer [1] a few diurnal series of free-air observations were reproduced graphically to illustrate the time-altitude changes in temperature accompanying pronounced changes in temperature at the surface. Since then many more series of observations by means of kites have become available, and an examination of these has been made with a view to selecting such as would be appropriate to the study of changes in free-air conditions leading up to rain or snow. The criterion for deciding which series would be suitable for reproduction was simply that the observations should extend to about 3,000 meters or more in altitude, and that they should be immediately or very soon followed by precipitation.

The purpose of this study was to correlate the sequence of temperature changes—and incidentally, of course, changes in other recorded elements—with the formation of precipitation. It has been thought helpful in interpreting the graphs to consider them separately by types, according to the direction of the surface wind prior to and during the occurrence of precipitation, and the position of the precipitation area with respect to the surrounding pressure distribution. Briefly, the types in this respect are those given in a preliminary paper on this subject by the writer,[2] and are as follows: (1) With easterly and northeasterly surface winds—therefore in the northern portion of a LOW area, or to the north of the nearest low pressure center; (2) with northwesterly surface winds, or in the rear of LOWS or front of HIGHS; (3) in the region of wind shift lines—ordinarily the south portion of LOWS; (4) with general southerly winds, or the southeast and east portions of a LOW.

Observations suitable for this study comprise only a small portion of all the observations made, the reasons being as follows: Kite flights are seldom deliberately made during the prevalence of rain or even when rain is imminent, and never when thunderstorms threaten, owing to the danger of destruction of kites and instrument in the former case, and additional danger of injury to personnel in the latter. During snowstorms there is ordinarily no danger of accident or injury, but as a rule observers prefer to complete their flights before the beginning of snow, or, when snow is falling, to delay starting the flight until after the snow has ended, owing to the fact that higher flights are possible in fair weather.

Records suitable for this study are therefore largely the fortunate outcome of series of flights terminated by precipitation, or in some cases, of series of flights in which the final flight was actually overtaken by storm. Notwithstanding these difficulties, the accumulation of records during the past few years offers the choice of quite a number of instructive series of free-air observations related to the occurrence of precipitation.

Some explanation is also appropriate here as to the meaning of "diurnal series." Apart from the ordinary routine at kite stations of making a single flight each day to as high an altitude as possible, the program of work includes the making of a series of observations at occasional intervals during the year when weather and wind permit. These observations consist of a succession of kite flights, one immediately following another, until about eight flights or so are made covering a period usually extending from the morning of one day to the afternoon of the next. Sometimes these attempted series are terminated after only a few flights have been obtained, on account of threatening weather or diminishing wind.

Limitations of space restrict the reproduction of the available series to a few well-developed specimens representing each of the so-called types of precipitation. This rather arbitrary division does not pretend to cover all possible types of precipitation occurring in the United States. This paper, moreover, necessarily deals only with the middle sections of the country, particularly the central portion, where, of all sections having primary aerological stations, free-air work has been carried on longest and most intensively. Furthermore, the discussion does not pretend to be a rigid analysis of the free-air processes attending precipitation. It is a presentation of some of these series of observations in "picturized" form, accompanied by such interpretation of them as the writer has felt competent to make.

No attempt has been made to interpolate the temperatures at the various altitudes with a view to making the altitude curves represent synchronous temperatures from the surface to the highest observation. In other words, the temperatures have been plotted at their respective altitudes without regard to time.

It had been hoped that charts of sea-level pressure would be available to accompany all these graphs, thereby helping to visualize the conditions they are intended to portray. It was found, however, that in only a few instances have the times of regular observation, on which the weather maps are based, coincided, even roughly, with the times of free-air observation and precipitation. Where these requirements of approximate simultaneity have been met, charts have been reproduced in connection with the graphs to which they refer; in the other cases it is thought that to reproduce them would serve no useful purpose. In this connection it may be pointed out that charts appropriate to Figure 4 are given in considerable detail in an article relating to the same storm that appeared in an earlier number of the REVIEW, reference to which is made in the text pertaining to that graph.

Comparison of free-air observations from stations 100 to 200 miles apart would be very interesting were such available. The distance between stations is, however,

[1] Jakl, V. E., Some Observations on Temperatures and Winds at Moderate Elevations above the Ground. MO. WEATHER REV., June, 1919, 47: 367-373.

[2] Jakl, V. E., A Preliminary Study of Precipitation in Relation to Winds and Temperature. MO. WEATHER REV., January, 1924, 52: 18-22.

never less than 300 miles. Hence no useful comparisons can be made between those few observations which weather conditions at two or more stations permitted to be made simultaneously. The different graphs wil be considered in groups in the numerical order of the types into which they fall.

(1) The series of January 27–28, 1916, the graph for which is shown in Figure 1, is cited to show an apparent

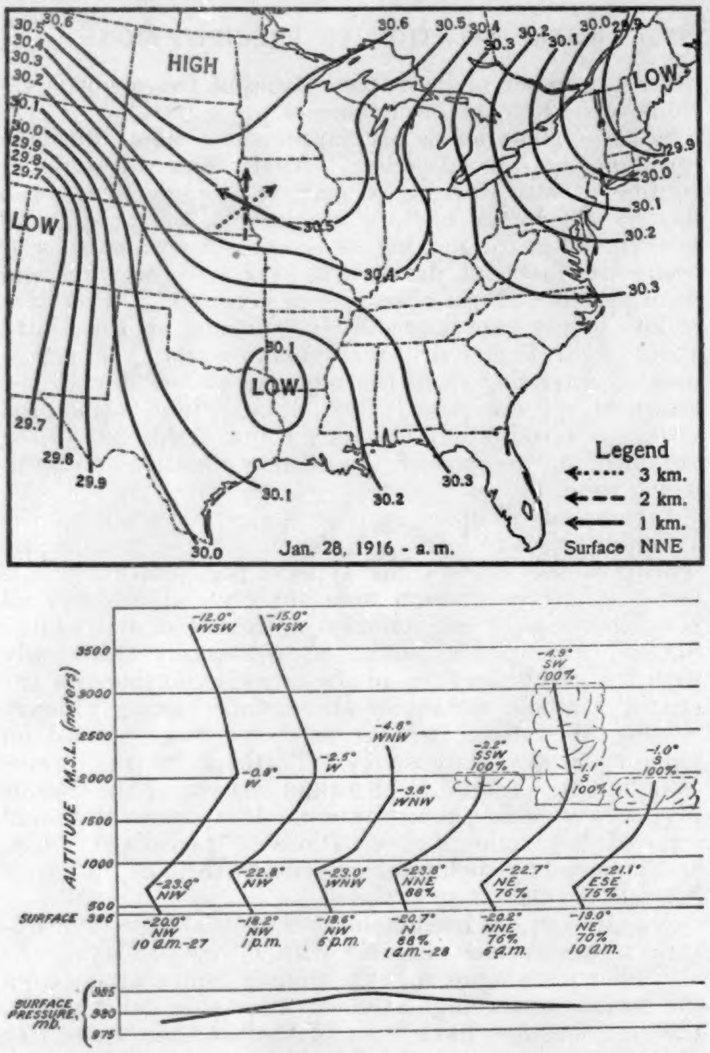


FIG. 1.—Sequence of free-air conditions at Drexel, January 27–28, 1916. Dotted lines at top of cloud area indicate that cloudiness extended to unknown height beyond upper limits of observation. Upper figure shows sea-level pressure at 7 a. m., ninetieth meridian time, January 28, and free-air winds over Drexel at approximately corresponding time

exception to the general rule that inversions are associated with drier air than that immediately below. Owing to the low temperatures that prevailed at the surface, the determinations of surface humidity from whirling psychrometer observations, which usually form the reference basis for reading free-air humidities recorded aloft, are not in this case reliable. Therefore humidities have not been entered on the graph except in the later flights of the series, where exposure of the kite instrument to dense clouds gave a saturation record as a reliable base of reference.

Considered in connection with the pressure distribution, which showed higher pressure north of Drexel, this series of observations apparently represents an ideal case of "warm-front" precipitation. However, in this case clouds were observed principally in that portion of the air column extending from the inversion level upwards throughout which a lapse rate somewhat less than the moist adiabatic for the existing temperature prevailed. No important change in temperature is shown in the vertical column from the morning of the 27th to the morning of the 28th, but it is apparent from the graph that clouds and precipitation formed soon after the wind in the upper levels changed to southerly. If, from the facts presented, one is disinclined to attribute the snowfall to a "warm-front" process, an alternative explanation is possible by supposing that the lapse rate above the inverson eventually became sufficient to cause vertical convection. This supposition is given credence by the fact that the snowfall was light until after the last flight, the snow having begun at 1.30 a. m. and ended about midnight on the 28th. Since the surface wind remained northeast and the pressure fell to about 6 a. m. of the

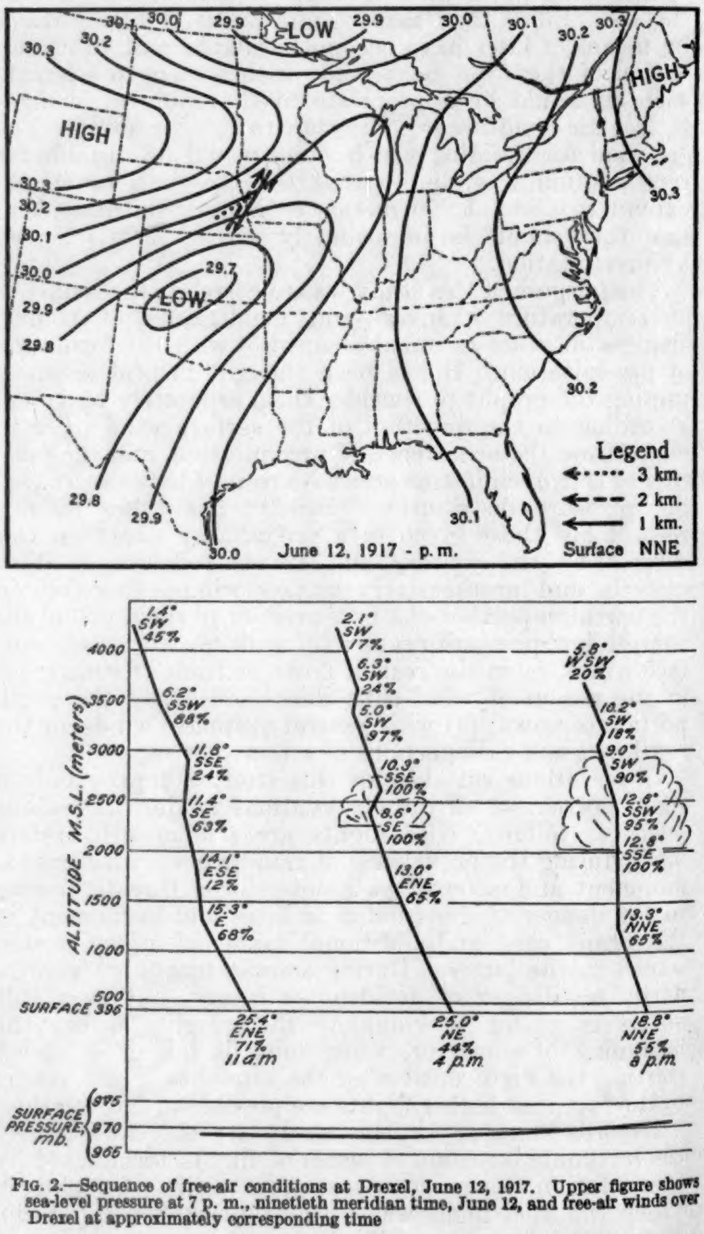


FIG. 2.—Sequence of free-air conditions at Drexel, June 12, 1917. Upper figure shows sea-level pressure at 7 p. m., ninetieth meridian time, June 12, and free-air winds over Drexel at approximately corresponding time

29th, it is apparent that the wind turned clockwise with altitude during the time that the snow fell.

Figure 2 is a graph of the series of three flights of June 12, 1917, showing free-air conditions up to about three hours before precipitation began. The wind veered with altitude from northeasterly on the ground to southwest-

erly aloft, but owing to lack of pressure fall and necessary convergence or other cause to impel ascent of air, precipitation did not occur until the pressure rose. The rise in pressure, occurring after the last flight of the series, was evidently accompanied by a change from clockwise to counterclockwise turning of the wind with altitude, resulting in an underrunning effect on the southerly winds aloft by the cold northerly winds near the ground. Evidence of the impending change to counterclockwise is shown on the graph by the abrupt change with altitude from north-northeast to south-southwest above 1,250 meters in the last flight; also by rising pressure and the fact that the surface wind changed from northeast to northwest soon after precipitation began.

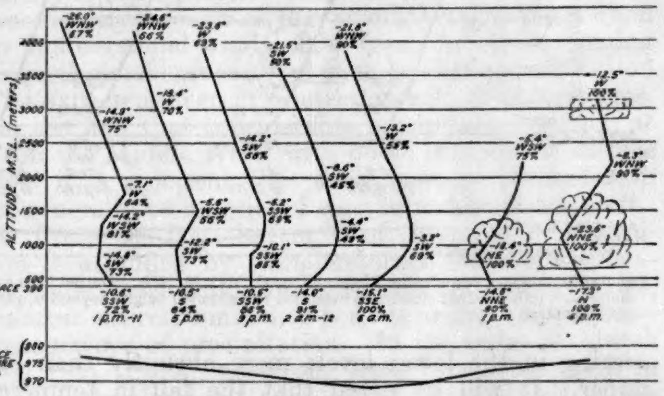


FIG. 3.—Sequence of free-air conditions at Drexel, December 11-12, 1917. Dotted lines at top of cloud area indicate that cloudiness extended to unknown height beyond upper limits of observation

A statistical study of changes in direction with altitude for the United States by C. LeRoy Meisinger,[3] shows that in passing from the front to the rear of a LOW through the northern quadrants, the change from clockwise to counterclockwise turning with altitude is found on the average in that portion of the LOW where the surface winds are northeast. Precipitation in this north portion of LOWS therefore occurs with both kinds of turning, and often with both kinds in the same storm, in the latter case veering with altitude being followed by backing with altitude. On June 12, 1917, precipitation did not begin at Drexel until the change to counterclockwise turning with altitude took place. It will be noted that there was a rapid rise in altitude of the inversion that first became evident as a slight interruption of the lapse rate at about 1,500 meters. Kites do not show fine distinctions in wind directions, but the observed change in direction from beginning to end of the series was sufficiently large to be accepted as authentic. Increasing humidity and cloudiness, having as an upper limit the surface of temperature discontinuity, resulted as the winds aloft veered from easterly to more southerly and southwesterly, and temperature became higher at progressively higher altitudes. While the record of humidity in portions of the clouded area in the third flight was actually slightly less than at corresponding levels in the second flight, this was apparently due to the clouds being somewhat broken at the time they were penetrated by the kite. It will be noted that in the clouded area below the inversion a decrease in the lapse rate resulted as the inversion rose and the temperature fell in the northeasterly winds below. This appears to be a further reason why no precipitation occurred until pressure rose attended by underrunning northeasterly to northwesterly winds.

[3] Meisinger, C. LeRoy, The Preparation and Significance of Free-Air Pressure Maps for the Central and Eastern United States, MO. WEATHER REV. SUPPLEMENT No. 21.

The series of December 11-12, 1917 (fig. 3) shows the conditions attending a very light snowfall when wind near the ground changed from southerly to north and northeasterly. The cold northeasterly winds from the body of the HIGH to the northwest simply displaced the southerly winds at the lower levels, while the upper winds remained about west. Such light precipitation as occurred was apparently due to the stratus cloud forming at the top of the northeast wind as a result of turbulence and mixture with the previously warmer air of south component. This vertical structure of the air is typical of free-air conditions attending the approach of cold waves.[4]

The series of February 11-12, 1919 (fig. 4), is another illustration of the conditions preceding precipitation occurring with northeast surface wind and southerly wind aloft. The surface wind became northeast when precipitation began three hours after the end of the last flight, and remained northeast throughout the 13 hours during which precipitation occurred with falling pressure. It will be noted that a marked inversion began in the lower levels as soon as the winds changed to a general southeasterly direction from the previous southwesterly direction soon after 1 a. m. This inversion was due to slowly rising temperature above and rapidly falling temperature below. The last altitude graph shows a fall in temperature at about 1,200 meters with an inversion immediately above, but no discontinuity in wind direction, indicating that the southeast wind below the inversion, with its attendant cloudiness, had a different source from the southeast wind at and above the inversion. The falling temperature evidently had its origin east or northeast of Drexel, while the rising temperature and low humidity at and above the inversion at 1,600 meters can be attributed to continued inflow from regions far to the south or southwest. Subsequent

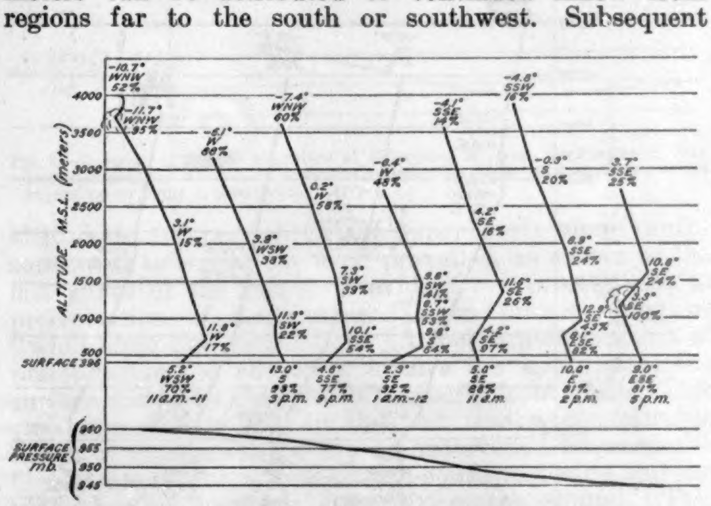


FIG. 4.—Sequence of free-air conditions at Drexel, February 11-12, 1919

observations are confined to the surface and show that the wind backed to northeast and temperature and pressure fell.

An analysis of this LOW, which caused widespread precipitation, was made by the late Dr. C. LeRoy Meisinger (The Great Cyclone of Mid-February, 1919, MO. WEATHER REV., October, 1920, 48: 582-586), his explanation of the cause of the attendant precipitation being based on his acceptance of the "warm and cold front" theory. In view of the fact that most of the precipitation at Drexel in this storm occurred with a northeast surface wind and falling pressure, this explana-

[4] MO. WEATHER REV., June, 1919, 47: 367-373.

tion appears plausible. However, as in the case of January 27–28, 1916 (fig. 1), an additional explanation appears justified to the effect that precipitation was caused by a moist adiabatic gradient resulting in the upper levels where southerly winds prevailed, surmounted by cold southwest winds at still higher levels. It should be noted in this connection that precipitation began first on the eastern and southeastern sides of the LOW, where no "steering line" was apparent, and gradually developed successively over the northern and western portions of the LOW.

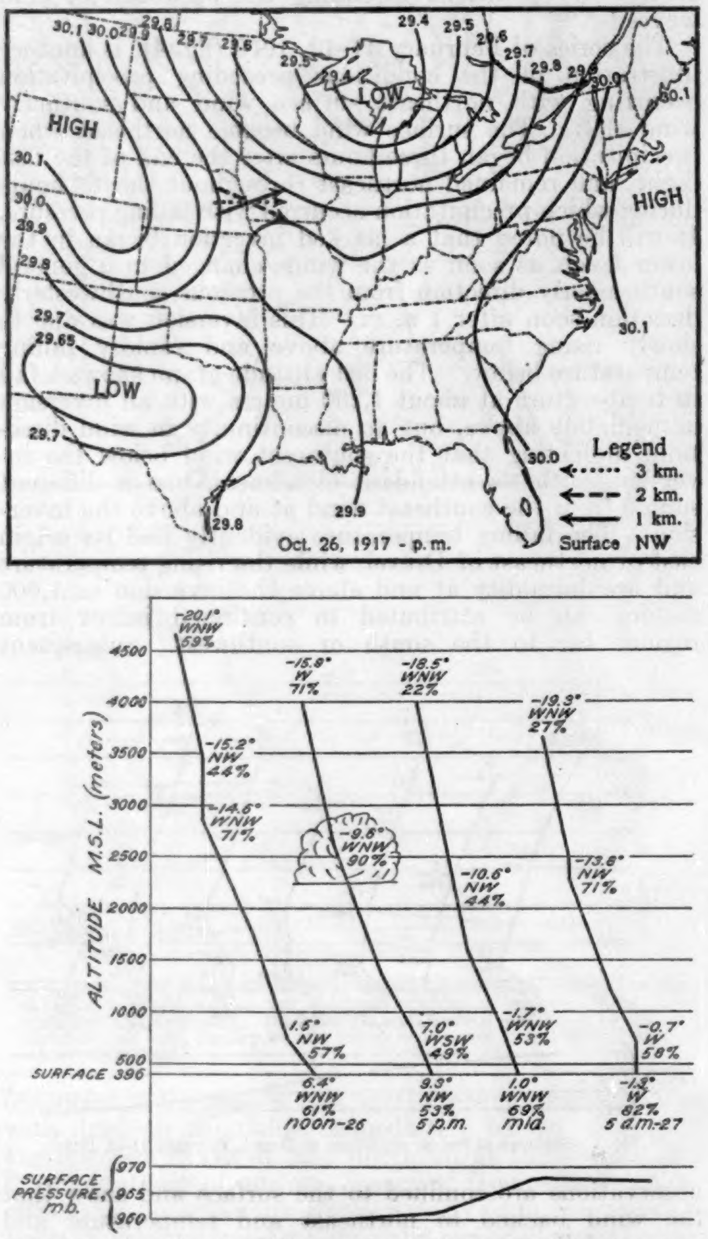


FIG. 5.—Sequence of free-air conditions at Drexel, October 26–27, 1917. Upper figure shows sea-level pressure at 7 p. m., ninetieth meridian time, October 26, and free-air winds over Drexel at approximately corresponding time

(2) The series of four flights of October 26, 1917 (fig. 5) shows the free-air conditions leading up to and following precipitation with northwest surface wind, 0.08 inch rain having occurred between the second and third flights. The second flight reveals an unbroken lapse rate, and, in the upper levels, generally higher humidity than in the first flight. This of course could not cause precipitation of consequence with the indicated wind directions, owing to their dry source. However, an abrupt surge of cold northwesterly wind in the lower levels with rapid rise in pressure, as shown between the second and third flights, was effective in causing precipitation by underrunning, the change to northwesterly

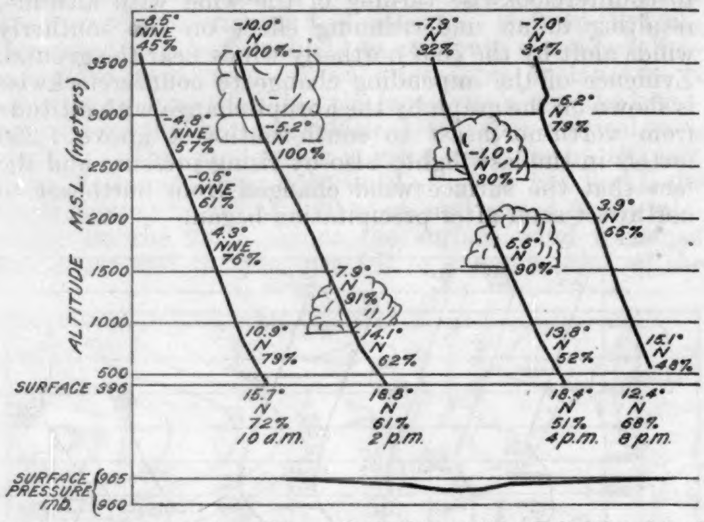


FIG. 6.—Sequence of free-air conditions at Drexel, May 19, 1919. Dotted lines at top of cloud area indicate that cloudiness extended to unknown height beyond upper limits of observation

coming in the lower levels more abruptly than in the upper. It will be noted that the fall in temperature observed immediately after the rain was greatest in the low levels near the ground.

The graph of the series of four flights on May 19, 1919 (fig. 6), shows conditions immediately preceding and following a light shower (between the second and third flights) where the winds were generally north to north-northeast up to 3,600 meters altitude. As might be expected from the circumstance of deep unidirectional winds of northerly component, only a small amount of precipitation (0.01 inch) occurred, notwithstanding that it was in the form of a thundershower. The temperature-altitude curves show a diurnal rise near the ground and lower levels, and sustained low temperatures aloft. A lapse rate approaching the dry adiabatic resulted, which in connection with strata of high humidity, made the column of air unstable. The pressure was stationary except during the prevalence of the thundershower, when a slight rise occurred accompanied by a

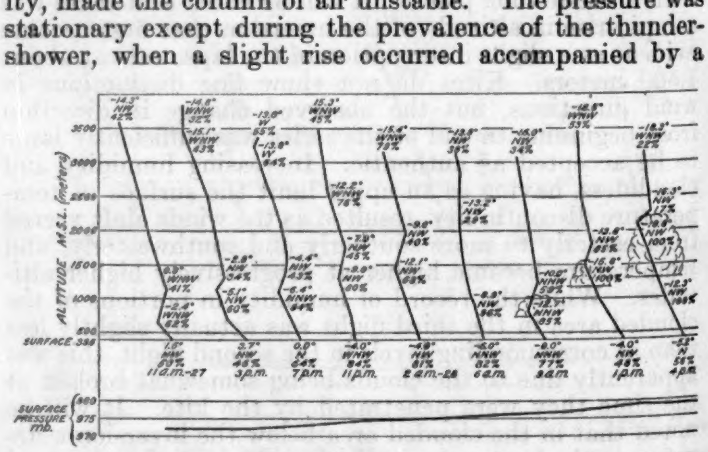


FIG. 7.—Sequence of free-air conditions at Drexel, February 27–28, 1920

decided fall in surface temperature. Evidently a slight surge in pressure was required to produce underrunning sufficient to cause precipitation. The strata of cloudiness preceding the thunderstorm were transported from regions to the east and northeast, where precipitation

was already occurring north of a low pressure center a few hundred miles southeast of Drexel.

This underrunning in a northerly wind is well illustrated for a winter condition in the graph of the series of flights on February 27–28, 1920 (fig. 7). In this case, however, there was evidently insufficient lapse rate and moisture content in the northwesterly winds of upper levels to cause precipitation, so that the trace of snow that did occur formed at the top of the underrunning stratum of cold air, a process which, owing to the gradual extension of the rapid fall in temperature into higher altitudes, formed a high lapse rate, resulting in turbulence and light precipitation.

While the preceding examples of the conditions in a northerly to northwesterly wind associated with precipitation cover only three cases, they strongly suggest that when deep unidirectional winds occur from directions ranging from north-northeast to about west, but little precipitation can be expected, even in connection with thunderstorms. From the fact that considerable precipitation occurs, at least in the Middle West, with north component surface winds,[5] it is apparent that such cases of precipitation must generally be associated with other directions aloft.

(3) From the fact that most of this class of precipitation is attended by thunderstorms, free-air observations under these conditions, particularly diurnal series, are almost entirely limited to periods preceding or following occurrence of precipitation. In the series of March 30–31, 1921 (fig. 8), no strong lapse rate is apparent in the upper levels above the diurnal rise and fall in the inversion layer. Instead, there occurred a gradual veering of the upper winds from southwesterly to westerly, and, until after the 3 a. m. flight, a rise of humidity which in general occurred at progressively lower altitudes. The last curve prior to the beginning of precipitation (3 a. m.) shows that the wind veered at all altitudes, though principally near the ground, and that the fall in temperature in the lower levels (below 2,350 meters)

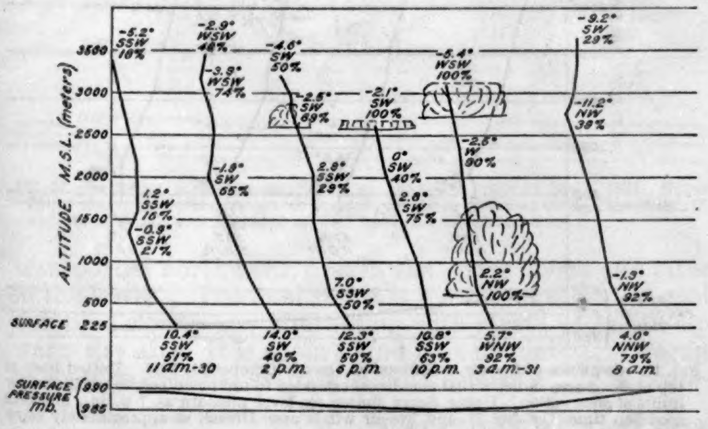


FIG. 8.—Sequence of free-air conditions at Royal Center, March 30-31, 1921. Dotted lines at top of cloud area indicate that cloudiness extended to unknown height beyond upper limits of observation

incidental to the veering of wind to the northwest reduced the lapse rate to a small value. This curve shows northwest wind on the ground gradually backing to west-southwest aloft. The amount of precipitation was small (0.03 inch), emphasizing what has already been brought out, viz, that at least in the great majority of cases of northwest wind not much precipitation can occur unless there is a more or less abrupt shift above it to a southerly wind.

[5] Mo. WEATHER REV., January, 1924, 52: 18–22; also Udden, Anton D., A Statistical Study of Surface and Upper Air Conditions in Cyclones and Anticyclones Passing over Davenport, Iowa, Mo. WEATHER REV., February, 1923, 51: 55–68.

The graph of Figure 9 shows the records of the upper air conditions in three flights on September 5, 1923, immediately preceding a shower of the typical squall type, with abrupt change in wind direction to northerly at and near the surface. The record of humidity and temperature below about 2,000 meters is missing in the last flight, owing to the collapse of the instrument-carrying kite and consequent blurring of the record when, in the process of reeling down, the kites encountered the northerly underrunning current with its attendant strong wind and clouds. The gradual rise in humidity with

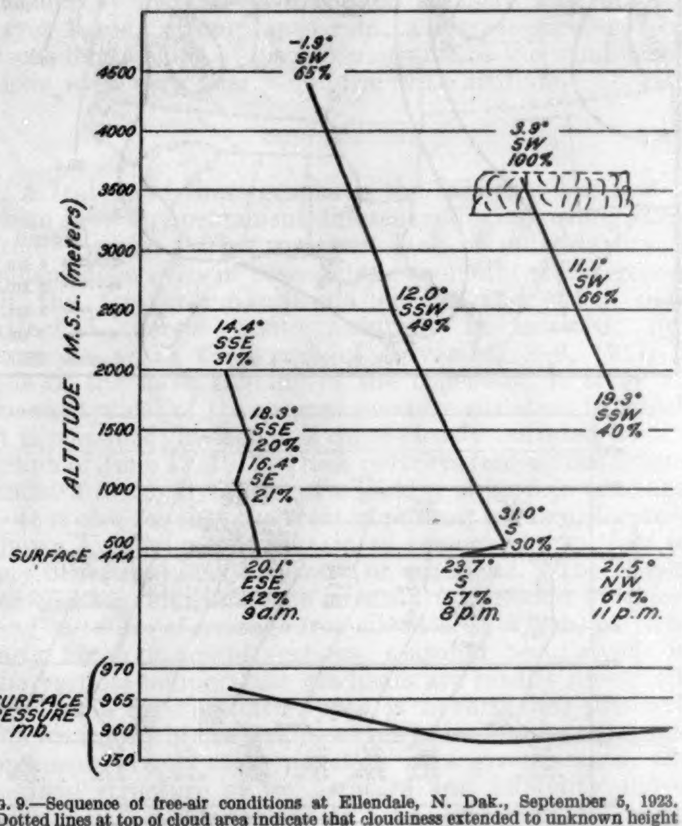


FIG. 9.—Sequence of free-air conditions at Ellendale, N. Dak., September 5, 1923. Dotted lines at top of cloud area indicate that cloudiness extended to unknown height beyond upper limits of observation

altitude to 100 per cent in the upper levels where south-southwest to southwest wind prevailed, as shown in the last curve of the graph, is evidently a prerequisite to precipitation of consequence in an underrunning or "wind shift line" condition. A measurable amount of precipitation did not occur until a few hours after the surface wind had changed to northerly from south. This was undoubtedly due to the fact that a considerable depth of comparatively dry air intervened between the high strata of clouds in the south-southwest wind and the underrunning northerly current near the ground. This column had a lapse of about 0.87° per 100 meters, or close to the dry adiabatic, and exceeding the moist adiabatic for the prevailing temperature. As the column of dry air was replaced to gradually greater vertical extent by moister air and cloudiness through accumulation from southern sources, an unstable condition supervened, which needed only displacement by an underrunning colder current to cause the vertical convection necessary to precipitation.

(4) Considering those cases where precipitation occurred in winds of general southerly component in the front of a LOW, the first graph reproduced will be that of the series of flights made at Drexel on November 8–9, 1917 (fig. 10). In this series a thunderstorm developed during the last flight before the kites could be reeled in,

resulting in lightning striking and destroying the steel kite line. The outstanding feature of the series is the gradual uninterrupted rise in the height of the convection column, in which a dry adiabatic lapse rate with cloudi-

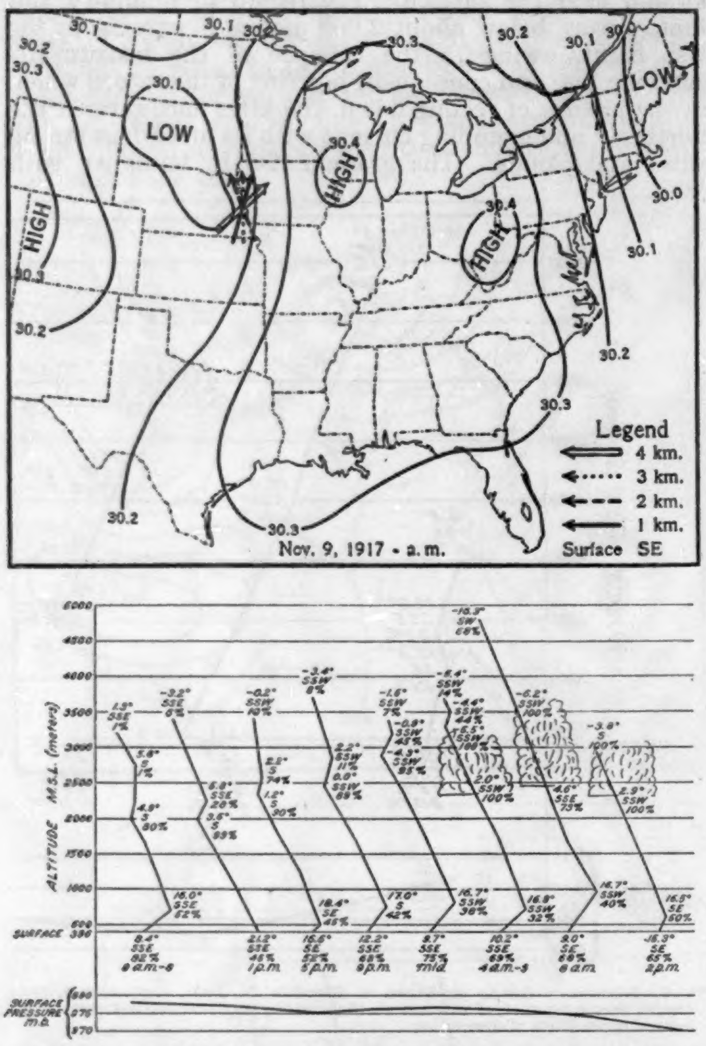


FIG. 10.—Sequence of free-air conditions at Drexel, November 8-9, 1917. Dotted lines at top of cloud area indicate that cloudiness extended to unknown height beyond upper limits of observation. Upper figure shows sea-level pressure at 7 a. m., ninetieth meridian time, November 9, and free-air winds over Drexel at approximately corresponding time

ness at the top, prevailed. From the fact that this occurred throughout the night it is obvious that the maintenance of this lapse rate must be attributed to reasons other than effects of insolation at the surface. The record of wind direction shows that the top of the convection column rose because air from the HIGH to the east became replaced at successively higher altitudes by air which had recurved from the rear of the LOW. A rapid fall in pressure brought about precipitation with a thunderstorm, probably by convergence, as the rain occurred with a southeast surface wind.

The series of four flights on October 21, 1918, shown in Figure 11, was made in connection with the advance eastward of a trough of low pressure that overlay the Rocky Mountain and Plains States on the morning of that day. High humidity and cloudiness prevailed in the upper levels from the early morning, and no appreciable change in temperature occurred throughout the vertical column of air during the course of the observations. It is therefore apparent that conditions of humidity and cloudiness favorable for precipitation were transported from regions to the south where precipitation was already occurring, but that the actual occurrence of precipitation over Drexel was delayed until the position of the advancing trough of low pressure caused convergence and underrunning. This is shown by the record of surface wind direction during the 27-hour intermittent rainfall, the surface wind varying during that time from southeast, through south to southwest, and finally northeast.

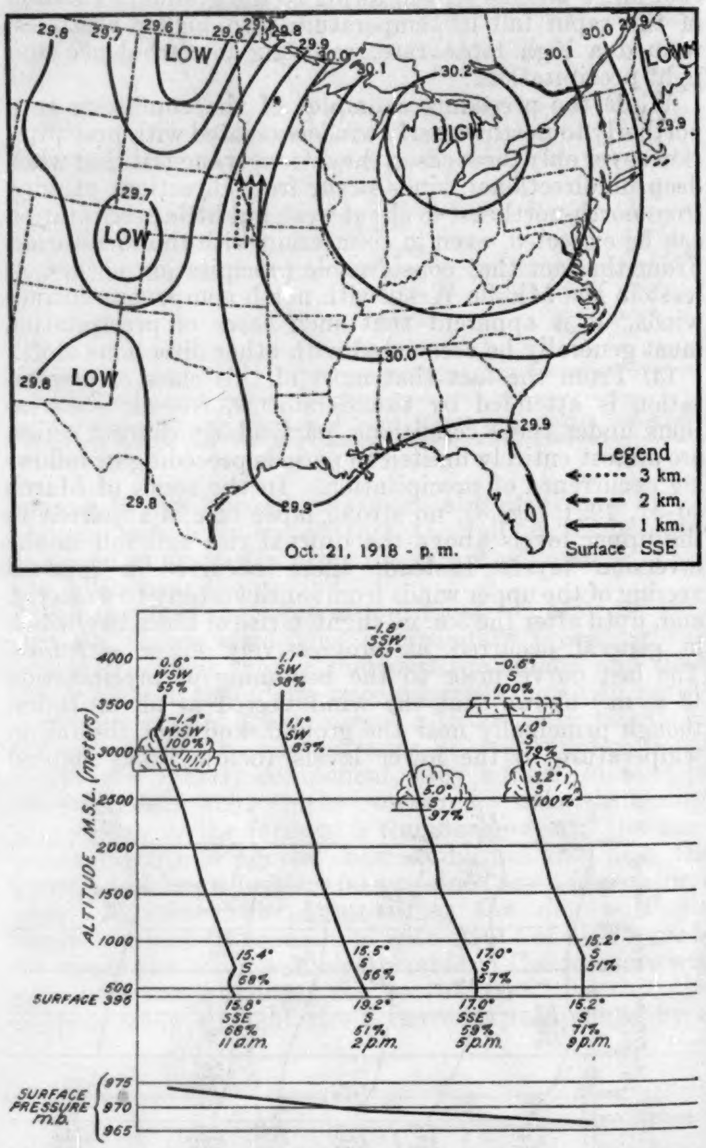
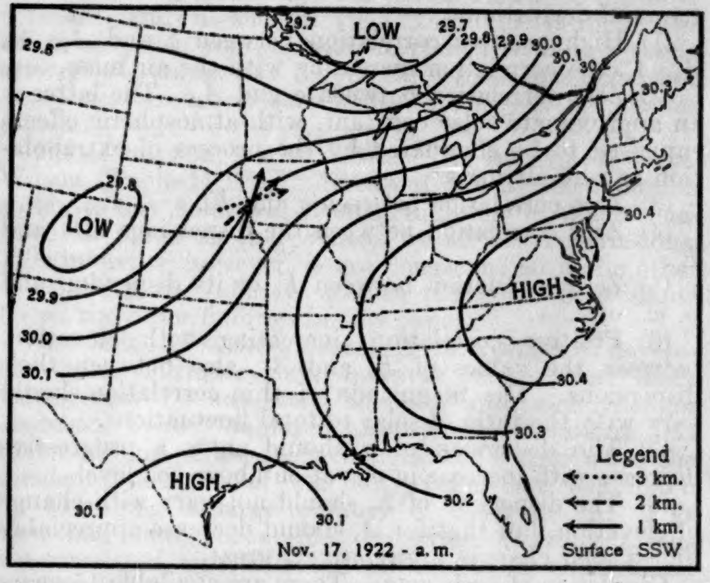


FIG. 11.—Sequence of free-air conditions at Drexel, October 21, 1918. Dotted lines at top of cloud area indicate that cloudiness extended to unknown height beyond upper limits of observation. Upper figure shows sea-level pressure at 7 p. m., ninetieth meridian time, October 21, and free-air winds over Drexel, at approximately corresponding time

The graph representing the series of November 16–17, 1922 (fig. 12) shows for the first 12 hours a dry state of the atmosphere extending to a considerable depth, and thereafter a rapid change to high humidity and cloudiness. It will be noted that the cloudiness began in the upper levels and spread to lower levels. Correlating these changes in humidity with the accompanying changes in temperature, we find a condition somewhat the reverse of that shown on November 8–9, 1917, i. e., lowering of temperature at progressively lower altitudes attending a backing of the wind from west-southwest to south-southwest. This change to colder accompanying a

change from westerly to southerly is contrary to what might be expected. However, the explanation is to be found in the fact that precipitation occurred first to the south, and as the gradient changed to cause south-southwest wind, cloudiness and lower temperature were



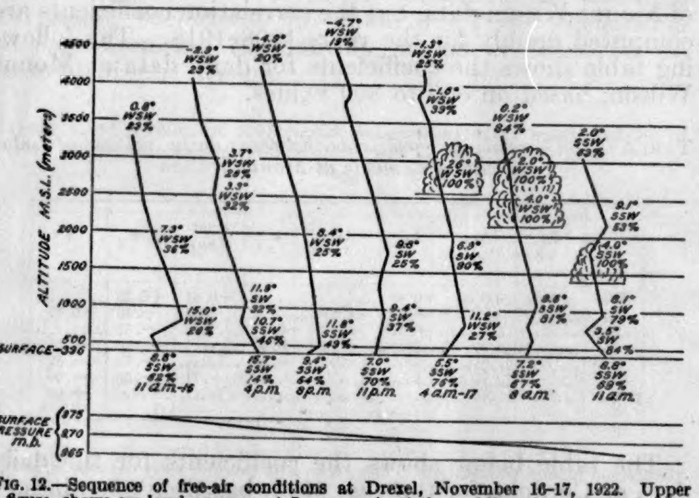


FIG. 12.—Sequence of free-air conditions at Drexel, November 16-17, 1922. Upper figure shows sea-level pressure at 7 a. m., ninetieth meridian time, November 17, and free-air winds over Drexel at approximately corresponding time

transported northward, first in the upper layers and later in the lower. The final result is a series of strata of cool damp or cloudy air, alternating with strata of relatively warm dry air. It is again found that precipitation began as soon as pressure started to fall decidedly. It is therefore probable that the mere transport of air from regions where precipitation is occurring can not of itself cause other than very light precipitation over the region affected. Whether such accumulation of clouded air is brought about in a deep layer having an unbroken lapse rate, or in a series of relatively shallow strata consisting of alternate lapses and inversions in temperature, it is apparent that in neither case is precipitation of consequence possible until there occurs the pressure change necessary to bring about forced ascent of air. The case of this series compels the opinion that rain was caused neither by instability, inasmuch as there was no deep layer having strong lapse rate in temperature, nor by ascending a slope of discontinuity, since the wind directions were very nearly uniform with altitude.

CONCLUSIONS

A feature of these graphs is the fact that but few of them show any prominent differences distinguishing them from the rest. This apparent lack of individuality is conspicuous even in cases where pronounced differences in the temperature-altitude curves and other data attached thereto would naturally be inferred. For example, while the graph of November 8-9, 1917, is one of the most striking of the collection, it is by no means typical of the general pressure situation in which it is classified; in fact it is quite closely imitated by the graph of June 12, 1917, which portrays free-air conditions under a decidedly different situation of surface pressure.

It is obvious that the most important group differences shown by the graphs pertain to seasons rather than to any other divisions, arbitrary or otherwise. The reason for this seasonal influence is easily understood by referring to tables of average free-air data, in which, particularly for continental sections, seasonal peculiarities in the vertical temperature gradients are readily identified. While the division into types is nevertheless justified, the testimony of the graphs seems to be that by whatever processes precipitation develops in a given season, the vertical structure of temperature and humidity shows substantial similarity when the precipitation stage begins.

The conclusion seems well founded that the various processes of precipitation formation ultimately resolve themselves into a free-air structure comprising strata of greater or less depth having lapse rates equal to or greater than the moist adiabatic rates for the prevailing temperatures. Notwithstanding this, consideration of precipitation types in connection with surface and free-air conditions should lead to a better understanding of the subject, to the end that these types and their development may be recognized on the weather maps.

A STATISTICAL ANALYSIS OF SOLAR RADIATION DATA

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SYNOPSIS

An attempt is made to determine by statistical analysis the degree of validity of the values of solar intensity derived from pyrheliometric or bolometric observations. Both correlation coefficients and the mean dispersion of the data are employed. Certain physical relations are assumed to exist between errorless elements of data and constitute criteria for determining the validity of derived values.

Numerous correlation coefficients between both the daily values and the monthly means of solar radiation elements at Mount Wilson are presented. A high negative correlation, averaging -0.55 to -0.60, between the apparent atmospheric transmission coefficient, a and the apparent solar constant, A_0, is a feature of all daily pyrheliometric data. This is known to be due to changing transparency between low and high sun observations. A similar high negative correlation both for daily values and monthly means exists between the solar constant, E'_0, and the transmission coefficient. Since zero correlation should exist between these elements, it is inferred that the derived values, E'_0, are a function of atmospheric transparency.

A high negative correlation, -0.60, between the mean monthly values of E'_0 and A_2, is regarded as strong evidence of the unreality of the variations of the monthly values of E'_0.

A high correlation, +0.87, exists between the yearly means of the scatter of a and of the scatter of E_0, and a negative correlation, −0.74, between the yearly means of A_2 and the scatter of E_0. These high correlations where none should exist show that the scatter of E_0 is due to atmospheric variations.

It is shown that as the elevation increases the scatter of both the observed intensity, A_1, and of the derived value of the solar constant, E_0, decrease *pari passu* with the scatter of a; and the inference is that these variations would almost vanish at the outer limit of the earth's atmosphere.

A selection of 53 high grade days at Mount Wilson, 1.8 km., yields a probable error of ±0.65 per cent for A_1, whereas the probable error of E'_0 for all days is 60 per cent greater.

Five sets of pyrheliometric observations taken by different observers at stations 3.3 to 4.5 km. in elevation give results substantially in agreement, in indicating that at 4.0 km. on high grade days with vapor pressure averaging 1.5 mm. the probable error of A_1 is about ±0.40 per cent.

Since the probable error of the pyrheliometer reading is about ±0.30 per cent, it is obvious that after allowing for the error of extrapolation to air mass one, and for residual atmospheric variations at an elevation of 4 km. little is left for possible solar variation.

Introduction.—The solar radiation data analyzed and discussed in this paper include the solar constant measurements made by Abbot [1] at Washington, Mount Wilson, Mount Whitney, Bassour, and Calama; and fragmentary pyrheliometer observations made under the direction of Bigelow [2] at Cordoba and La Quiaca, Argentina, and at La Confianza, Bolivia; and by the Ångströms at the Peak of Teneriffe [3] and Mount Whitney.[4]

Following the notation of the Astrophysical Observatory, the symbols representing the elements referred to in the paper are, e, the vapor pressure in millimeters; *p. w.* the precipitable water in the entire atmosphere above the station as determined by the bolometer; a, the apparent atmospheric transmission coefficient, or the coefficient for a definite wave length, as 0.8 μ; A, the intensity of solar radiation at the earth's surface, with subscripts *0, 1, 2, 3,* etc., to indicate the air mass. If the sun be in the zenith, the intensity is A_1; E_0 is the solar constant, or E'_0 with water vapor correction applied. The mathematical relations between the pyrheliometric data are simply expressed by the formulas, $A_1 = A_0\, a$; $A_2 = A_0\, a^2$.

The statistical processes which have been employed in the investigation include the computation of coefficients of correlation for both daily values and monthly means, and the determination of the mean day-to-day variability for each year for all the elements. The method of correlation mainly employed is that described in this REVIEW, volume 52, 1924, page 424. The mean variability, or the mean of the consecutive variations without regard to sign, is regarded as the appropriate index of dispersion for employment in this investigation, because it is wholly independent of any secular or seasonal variations which may occur in one element and not in the other and which would render the standard deviations of the two elements not comparable with each other.

Physical relations between elements of data.—For the interpretation of the statistical coefficients, certain physical relations which should be found between these elements are presented below because they constitute criteria for determining the validity of the derived values available for analysis. Such data comprise all values derived from the pyrheliometric observations of intensity, including a, A_0, A_1, also from the bolograph trace, as E_0, E'_0, *p. w.* and a_λ. The symbols and items of data are assumed to represent real values, unaffected either by errors of direct observation or by the frequently greater errors of derivation.

(1) High positive correlation between a and A_1, A_2, A_3, A_4, the correlation increasing with the air mass.

(2) Zero correlation between a and A_0. The latter is an approximate solar constant, with atmospheric effects supposed to be eliminated by the process of extrapolation to zero air mass.

(3) Zero correlation between a and E_0.

(4) Zero correlation between the dispersions of a and E_0.

(5) Zero correlation between E_0 or its dispersion, and *p. w.*, or e.

(6) Positive correlation, increasing with elevation, between the values of E_0 and A_1, also between their dispersions. The magnitude of this correlation should vary with the ratio of solar to total fluctuations.

(7) The dispersion of a should show a progressive decrease with increase in elevation above sea level.

(8) The dispersion of E_0 should not vary with change of elevation, but that for A_1 should decrease appreciably unless solar changes are relatively great.

Correlation of daily data.—There are available 15 years of Mount Wilson data, but the correlation coefficients are computed mainly for the years 1908–1918. The following table shows the coefficients for daily data at Mount Wilson, based on 500 to 800 values.

TABLE 1.—*Correlation coefficients between daily values of solar radiation elements at Mount Wilson*

	E_0	A_0	A_1	A_2	a	a (at 0.8μ)	*p. w.*	e
E'_0	+0.92	+0.66	+0.49			−0.61	+0.23	
E_0		+.71	+.59	+0.27		−.57	−.40	−0.42
A_0			+.77	+.42	−0.51		−.52	
A_1				+.74	+.40		−.70	−.51
A_2					+.80		−.73	−.52
a						+.71	−.56	−.40
p. w.								+.60

The table below shows the coefficients for the daily data at Cordoba for the year 1912, based on 85 values.

TABLE 2.—*Correlation coefficients at Cordoba*

	A_0	A_1	A_2	A_3	A_4
a	−0.57	+0.38	+0.81	+0.88	+0.89
A_0		+.71	+.25	−.28	−.28
A_1			+.69	+.61	+.60
A_2				+.95	+ 95
A_3					+.99

Tested by criterion (1) above, the positive correlations of a with A_2, A_3, A_4, are physically consistent, but the magnitude of the coefficient for A_1 seems too low. The comparatively large negative correlation between a and A_0 is a characteristic of all pyrheliometric data.[5] For example, at Washington it is −0.51; at Bassour, −0.65; Helwan, −0.70; Hump Mountain, −0.70 and at La Quiaca, −0.51. The existence of this high negative correlation between a and A_0 is evidence of atmos-

[1] Annals of the Astrophysical Observatory, Vol. III, 1913; IV, 1922. Washington. By C. G. Abbot, Director.

[2] Bigelow, F. H. The Thermodynamics of the earth's atmosphere from the surface to the vanishing plane. Oficina Meteorológica Argentina. Boletin 4, 1914. Buenos Aires.

[3] Ångström, Knut. Intensité de la radiation solaire à différentes altitudes. Recherches faites à Ténériffe, 1895 et 1896. Upsala, 1900.

[4] Ångström, A. K. and Kennard, E. H. Some pyrheliometric observations on Mount Whitney. Astro. Jour., 39-350. 1914.

pheric control (Criterion 2), and is the result of changing transparency between low and high sun observations.[6]

Referring to Table 1, there is shown a coefficient of -0.61 between E'_0 and the transmission coefficient a at wave length 0.8μ. This is higher even than the correlation between a and A_0. Real values of the solar constant and a should yield zero correlation. *The existence of this high negative correlation between a purely atmospheric datum and alleged daily solar constant values constitutes strong evidence against their reality as solar changes.*

The correlation, $+0.49$, between E'_0 and A_1, at Mount Wilson (Table 1) if considered entirely by itself implies a day-to-day solar variation amounting to about one-third as much as that caused by all other variations. This inference, however, is not consistent with the other correlations in Table 1, and is, moreover, invalidated by all the other findings in this paper.

Correlation of monthly data.—The advocates of day-to-day solar changes may, however, argue that daily values may be adversely affected, and such changes obscured, by uneliminated atmospheric variations, but that real long-period solar changes will appear when the accidental features of the daily values are eliminated by averaging a large number of observations. This view has some plausibility, but when monthly means are correlated, similar close relations, where none should be found, are still in evidence as shown by the high correlation coefficients in Table 3. These coefficients are based on the 75 monthly means available for 15 years at Mount Wilson.

TABLE 3.—*Correlation coefficients between monthly mean values of solar radiation elements at Mount Wilson, 1905–1920*

$n=75$

	E_0	A_0	A_1	A_2	a	a (at $.8\mu$)	$p. w.$	e
E'_0	+0.85	+0.45	−0.48	−0.60	−0.67	−0.64	+0.42	
E_0		+.56	+.12	−.35	−.54	−.66	−.31	
A_0			+.62	+.43	−.33	−.35	−.48	
A_1				+.84	+.62	+.58	[1] −.80	[1] −0.57
A_2					+.79	+.62	[1] −.77	[1] −.52
a						+.83	[1] −.60	[1] −.50
$a. 8\mu$							[1] −.43	[1] −.50
$p. w.$								+.46

[1] Exclusive of the years 1912 and 1913, on account of Katmai dust causing abnormally depressed values of a and A_1.

The correlation between E'_0 and a at wave length 0.8μ is -0.64 ± 0.05, as compared with -0.61 for the daily values. As in the case of the latter, this high negative correlation where none should exist, forbids any conclusion that the monthly differences of E'_0 represent, even approximately, real solar changes.

If solar changes occur from month to month, there should be a positive correlation between E'_0 and A_1 (Criterion 6), and less correlation, but still positive, between E'_0 and A_2. These observations over a period of 75 months, however, show a *high negative correlation, -0.60 ± 0.05,* between E'_0 and A_2 which is to be interpreted as additional striking evidence that the fluctuations of even the monthly means of E'_0 at Mount Wilson are caused by atmospheric and terrestrial rather than solar changes. The value A_2 is a purely terrestrial datum obtained by practically direct observation.

The correlation of E_0 with A_2 is less than that of E'_0, while for E_0 and A_1 there is a small positive correlation. This may mean that E_0 is a more representative value of the solar constant than E'_0. It is more probable however that it means simply that the systematic influences tending to cause a high negative correlation of E'_0 with A_2 are somewhat less operative in the case of E_0.

Incidentally, it may be stated that the correlation between the monthly means of E'_0 and the monthly sunspot numbers is -0.29 ± 0.07, certainly very slight evidence of relationship. On the other hand, the correlation of the sunspot numbers with a purely terrestrial datum, A_2, is $+0.56 \pm 0.05$. There is as yet no satisfactory interpretation of this rather large coefficient.

The intensity, A_2, has, as must be expected, a high negative correlation, -0.77, with the precipitable water. Mean monthly values of these elements in Table 4 below show well marked annual periodicities with phases in opposition, i. e. a maximum $p. w.$ and a minimum A_2 in July, which is consistent with the high negative correlation. The negative correlation between $p. w.$ and a, $-.60$, is also consistent with the opposition in phase, of their annual fluctuation.

TABLE 4.—*Monthly means of solar radiation elements at Mount Wilson, 1905–1920*

Element	May	June	July	Aug.	Sept.	Oct.	Nov.
$p. w.$ (mm)	7.0	8.3	11.7	11.1	9.5	8.4	5.1
[1] A_2 (cal.)		1.398	1.370	1.370	1.393	1.413	1.430
[1] E_0 (cal.)	1.935	1.945	1.946	1.945	1.940	1.939	1.931
[1] a		.889	.887	.887	.894	.900	.910
e (mm)	4.6	5.3	5.9	5.8	5.0	4.4	3.8

[1] Abnormal values in 1912 and 1913 were disregarded in deriving the means for E'_0, A_2, and a.

The high negative correlation, -0.60 ± 0.05, Table 3, between E'_0 and A_2, derived from the month to month changes, should likewise lead us to infer *an annual periodicity in E'_0 opposite to that in A_2.* The mean monthly values confirm this deduction from the correlation coefficients. The positive correlation $+0.42$, between $p. w.$ and E'_0, is likewise confirmatory.

The existence of this annual period is further evidence of the unreliability of E'_0 as a measure of solar intensity.

The mean variability of the data at Mount Wilson.—Considering now the other statistical index utilized, there are found similar close relations between alleged solar and purely terrestrial data.

The mean value and the mean variability of a number of solar radiation elements as computed for each year for Mount Wilson are shown in the following Table 5 with the averages for the whole period, excluding 1912, when the Katmai dust caused abnormal yearly means and an excessive scatter of all data. These yearly mean variabilities are derived from day-to-day changes, averaging about 75 per year. This measure of dispersion is independent of any systematic or secular variations occurring in one variant and not in the other; moreover, as already pointed out it is through the day-to-day changes that E_0 and a are so closely related.

[5] More clearly to reveal the fact that the daily values have a high negative correlation the formula employed must exclude the influence of the marked seasonal variations in a, which strongly affect the coefficients obtained by the ordinary method. This is accomplished by the formula used in the present instance. Thus, the Mount Wilson data selected by Abbot in his paper "The temperature and radiation of the sun," (Astrophys. Jour., 1916), to prove the nonexistence of an alleged negative correlation between a and E_0, yield by the ordinary method only -0.06 ± 0.10, an apparently negligible amount. Correlating the same data by the method used in this paper gives a coefficient of -0.58 ± 0.07.

[6] On days when the intensity at a large air mass, A_4 for example, is very low, there is a low real value of a; but with the tendency to increased transparency toward midday, frequently characteristic of such days, a, the apparent transmission as measured by the slope of the line joining the low and high sun observations, is too low and there result too high values of A_0. With a high value of A_4, on the other hand, there is associated a high real value of a, but since there is on such days a tendency toward decreasing transparency, caused by strong convection and increased evaporation, the depressed slope of the line causes too high values of the apparent transmission and too low values of A_0.

TABLE 5.—*Yearly means and yearly mean variabilities of solar radiation data at Mount Wilson*

Year	Yearly mean			Mean variability (±)			
	a	e	A_2	a	E_0	A_0	A_1
		mm.	*cal.*		*cal.*	*cal.*	*cal.*
1905	0.896	7.4	1.397	0.018	0.040	0.053	------
1906	.893	6.2	1.395	.013	.033	.053	------
1908	.886	4.8	1.379	.013	.033	.038	0.033
1909	.895	5.3	1.400	.013	.036	.041	.041
1910	.900	5.4	1.408	.012	.036	.043	.039
1911	.902	5.1	1.428	.012	.036	.041	.034
1912	.837	5.0	1.220	.030	.072	.059	.049
1913	.878	4.8	1.314	.016	.044	.047	.040
1914	.892	5.1	1.374	.014	.034	.045	.041
1915	.895	4.4	1.413	.012	.027	.047	.043
1916	.888	5.2	1.382	.015	.030	.044	.033
1917	.881	5.5	1.353	.017	.032	.042	.041
1918	.888	5.6	1.368	.017	.032	.048	.045
1919	.884	4.6	1.360	.014	.024	.043	.045
1920	.886	5.5	1.353	.017	.031	.042	.048
Means	.890	5.6	1.380	.014	.033	.043	.040

Table 5 shows the relative amounts of scatter expressed in calories for A_1, A_0, and E_0. The average yearly mean of A_1 is 1.56 cal.; of A_0 1.74 cal. A part of the scatter of A_1 is due to the error of extrapolation from the high sun observation, the air mass varying from about 1.2 in June to 1.5 in October.

This is shown by the small values of the correlation between A_1 and a, +0.40 at Mount Wilson, in latitude 34°, Table 1, and +0.38 at Cordoba, in latitude 31°, Table 2. At La Quiaca, on the other hand, in latitude 22°, the correlation is +0.50. The smaller coefficients at higher latitudes are very likely due to increased scatter involved in extrapolation from a larger air mass.

Extrapolation increases scatter at air mass zero but reduces scatter due to day-to-day changes in air transparency. The net result, however, as shown by Table 5, is that the scatter of A_0 differs but little from that of A_1. At Mount Wilson the mean variabilities of these values, in percentages, are A_1, ±2.57; A_0, ±2.47. At La Quiaca the variabilities are A_1 ±1.34; A_0, ±1.28. At Cordoba the percentage variability of A for various air masses is as follows: A_4, ±12.3; A_3, ±8.6; A_2, ±5.3; A_1, ±3.7; A_0, ±4.0.

It is clear, therefore, that the error of extrapolation is responsible for a very considerable part of the scatter of A_1, and for a still larger proportion of the scatter of A_0. Since the correlation of A_0 and E_0 is very high, +0.71 (Table 1), it is inferred that the scatter of E_0 is very largely of terrestrial origin.

The yearly means in Table 5 show rather high correlation. Between a and A_2, it is +0.87. (Criterion 1.) Some of the data in this table are plotted in Figure 1. It is clear that the yearly scatter of E_0 varies directly with the scatter of a and inversely with the mean intensity A_2. (The scatter of E'_0 is only 1 per cent less than that of E_0.) The correlation between the data of curves 1 and 2 is +0.87±0.05; between curves 1 and 3 it is −0.74±0.07, the latter curve being inverted. (These correlations were computed by the ordinary method, there being only 15 values.) It will be seen that in 1912, the year of the Katmai eruption, and to a less extent in 1913, the scatter of E_0 and a was abnormally increased and the intensity A_2 decreased. (Cf. Criteria 4 and 6.)

In curve 1 a dotted line drawn from 1911 to 1914 shows the probable course in the intervening years if the Katmai dust had not prevailed. Thus adjusted, curve 1 shows a high correlation with curve 4, the mean vapor pressure. Theoretically, the correlation between these elements should be zero. (Criterion 5.)

Here again, the yearly data, based on more than 1,000 daily values, show high coefficients where zero correlation should exist, and confirm the previous inference from the monthly means and the daily data that *a very large part, if not all, of the variations in E_0 must be ascribed to atmospheric causes.*

Smallness of possible solar variation shown by progressive decrease in scatter of all data with increasing altitude.—If solar variations are a large part of the day-to-day changes in E_0, or derived values of the solar constant, and the errors are small, then the higher in the atmosphere the daily observations are made, the more must the errors diminish and the variations of E_0 become relatively greater. What do the data show?

There are available for this purpose observations at the following stations: Washington, 39° N.; Mount Wilson, 34° N.; Mount Whitney, 37° N.; Teneriffe, 28° N.; Bassour, 36° N.; Calama, 22° S.; La Quiaca, 22° S.; La Confianza, 22° S.; Cordoba, 31° S. Washington and Cordoba are low-level stations having somewhat similar characteristics. Mount Wilson is a peak well within the limit of the lower convection currents. Mount Whitney has an elevation above the lower convection layer, insuring great steadiness of atmospheric conditions except for local ascending currents near midday in the vicinity of the peak. La Quiaca and La Confianza are on a high plateau in a dry region.

The mean variability [7] of various elements for each of the stations is given in Table 6, and plots of the percentage variability for a and A_1 are shown in Plate 1, Figure 2, and for a and E_0 in Figure 3.

TABLE 6.—*Mean value and mean variability of solar radiation elements at stations with elevations ranging from sea level to 4.5 kilometers.*

Years	Stations	Elevation, meters	Mean value			Mean variability (±)				Per cent	
			A_1	e	a	a	A_1	A_0	E_0	a	A_1
			cal.	*mm.*			*cal.*	*cal.*	*cal.*		
1905–1907	Washington	10	1.364	6.0	0.818	0.051	0.098	0.112	0.115	6.5	6.8
1912–13	Cordoba	450	1.440	9.0	.828	.031	.052	.067	------	3.8	3.7
1911	Bassour	1,160	1.456	7.8	.856	.027	.042	.045	.060	3.3	2.9
1912	do	------	1.340	7.2	.801	.041	.069	.083	.034	5.1	5.1
1908–1920	Mount Wilson.	1,750	1.560	5.0	.890	.014	.039	.044	.034	1.6	2.5
1912	do	------	1.494	5.0	.844	.030	.049	.059	.070	3.6	3.3
1918–19	Calama	2,200	1.590	6.0	.902	.010	.035	.033	.026	1.2	2.2
1913	La Quiaca	3,500	1.700	1.5	.903	.008	.023	.024	------	0.9	1.4
Do	Mount Whitney.	4,420	1.700	2.5	.930	.006	.015	------	------	0.6	0.9
Do	La Confianza.	4,460	1.740	1.3	.929	.004	.014	------	------	0.4	0.8

It should be borne in mind that the mean *variabilities* of these pyrheliometric observations at different stations are comparable, although the instruments or the methods of reading them may not be standardized to yield comparable *absolute* values. As should be expected (cf. Criteria 7 and 8), wide fluctuations in the observed intensity, A_1, associated with similar fluctuations in the transmission coefficient, a, occur at sea level with the entire mass of absorbing and scattering atmosphere above the station. Thus at Washington the mean variability of the two elements is about ±7 per cent.

[7] The ratio of the probable error to the mean variability is 0.60; to the mean deviation it is 0.85.

On the other hand at the extreme highest stations the variability of A_1 is reduced to ± 0.85 per cent.

It is clear, therefore, that the pure pyrheliometric data show progressively less scatter as we ascend in the atmosphere, and furthermore that the percentage variability of the scatter of a is approximately equal to, and proceeds *pari passu* with that of A_1 as shown by the fidelity with which the data lie along the line, drawn at 45°, joining equal percentages of mean variability of a and A_1.

The inference from the diagram is that at still higher elevations the variations of A_1 would show a proportional decrease. If, however, real solar variation exists, the line joining the variabilities of a and A_1 would, at the limit of the atmosphere, intersect the x-axis at an appreciable distance to the right of the origin. The scatter of a would vanish, and the scatter of A_1, exclusive

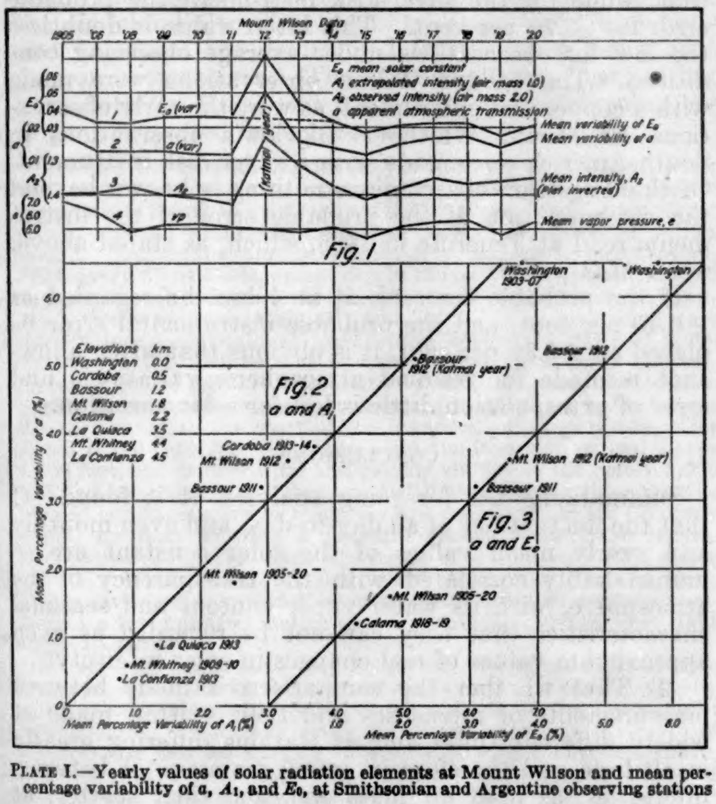

PLATE I.—Yearly values of solar radiation elements at Mount Wilson and mean percentage variability of a, A_1, and E_0, at Smithsonian and Argentine observing stations

of instrumental error, would obviously coincide with that of the real E_0 at this point.

Figure 3 shows a similar progressive decrease in the scatter of E_0 as the elevation of the station increases. The stations are those of the Smithsonian Institution, and the values for E_0 are those made by the long method only, and hence are entirely comparable. The scatter of the values obtained by the pyranometer method at Calama is about half that by the long method. The closeness with which the data lie along the 45° line is remarkable and indicates *correlation in excess of +0.90 between the variations of a and E_0 at different stations.*

The small value of the scatter of E_0 at Calama, for example, is due entirely to the correspondingly small scatter of the atmospheric transmission coefficient at this point, and hence can not be held to result from any improvement in the method of reduction.

What the observations show, therefore (figs. 2 and 3), is a very rapid diminution of all variations, both of the intensities A_1 and E_0, and of a. If solar variability formed even one-half of the variations of A_1 at Mount Wilson or Calama, the latter should cease to diminish, even though the variations of a vanished altogether. Instead, all the variations diminish *pari passu* almost as if they would vanish at the same time, and one is compelled to interpret those results as fixing the range of possible solar variation, if it exists at all, as only a small fraction of 1 per cent.

Smallness of possible solar variation shown by small scatter of A_1 at very high altitudes.—There are data available from four stations, all occupied before 1914. K. Ångström made a series of observations of high merit at Teneriffe in 1896, June 21 to July 3. At Alta Vista, 3,260 meters, observations were taken near midday on eight days and the mean of the maximum intensities was 1.612 cal., with a mean deviation of ± 0.010 cal., or ± 0.62 per cent. At the Peak, 3,700 meters, observations were obtained on two days, the difference between them being 0.008 cal. The 10 observations yield a mean deviation of ± 0.54 per cent. The air mass in no case exceeded 1.01. The mean vapor pressure was 2.8 mm. At Alta Vista the correlation between the observed pressure and the maximum intensity, A_1 is $+0.65$. Applying a correction to the data, A_1 for variation in pressure, the mean deviation is reduced from ± 0.62 per cent to ± 0.47 per cent.

Ångström made eight simultaneous readings with the two instruments he employed there. The means of the two series of readings were identical, and from the mean of the differences between them, ± 0.011 cal., the probable error of a single observation by one instrument is computed to be $\frac{.011 \times .6}{1.61} = \pm 0.41$ per cent. The maximum readings at Alta Vista, corrected for pressure, gave a mean deviation of ± 0.47 per cent. The probable error would be 85 per cent of this, or ± 0.40 per cent, which is about the probable instrumental error.

In 1909 and 1910 Abbot made observations at Mount Whitney, four of which he reduced and published in Vol. III of the Annals. These four days, together with a fifth day of high grade, August 25, 1909, yield a mean deviation of ± 0.47 per cent from the mean of A_1, 1.70 cal. The mean vapor pressure was 2.2 mm.

In August, 1913, A. K. Ångström made observations on eight days at Mount Whitney. Bigelow's determination of A_1 from Ångström's data gave a mean of 1.664 cal., with a mean deviation of ± 0.54 per cent. The mean deviation of the transmission coefficient, a, was ± 0.55 per cent. The smallest air mass ranged from 1.09 to 1.80. The mean vapor pressure was 2.7 mm.

In August and September, 1913, pyrheliometric observations on eight days were made at La Confianza under the direction of Bigelow, and his reductions show a mean value of A_1, 1.740 cal., and a mean deviation of ± 0.59 per cent. Mean vapor pressure was 1.3 mm. The mean deviation of a was ± 0.32 per cent.

These four independent series, at elevations ranging from 3.25 to 4.5 km., yield mean deviations of A_1, ranging from ± 0.47 per cent to ± 0.59 per cent, with an average of ± 0.54 per cent. While the total number of the observations, 31, is not large, yet in view of the noteworthy consistency of the results it seems reasonable to infer that at an elevation of 4.0 km. on days of a high grade of excellence with vapor pressure 2.0 mm. or less, the mean deviation of A_1 will average not greater than ± 0.50 per cent of the mean, and the probable error around ± 0.40 per cent.

Smallness of possible solar variation shown by small scatter of A_1 on days with very low vapor pressure.—(*a*) *at La Quiaca.*[8]—Values of A_1 for 1913 were grouped for definite ranges of vapor pressure and the results are shown in Table 7.

TABLE 7.—*Influence of atmospheric water vapor on values and scatter of A_1 at La Quiaca*

Cases	Range of vapor pressure	Mean variability of A_1		Mean value A_1
	mm.	*cal.*	*per cent*	*cal.*
[1]9	0.4 to 0.7	0.011	0.62	1.780
31	0.4 to 1.2	.017	.95	1.760
20	1.3 to 2.2	.023	1.34	1.720
19	2.3 to 4.7	.029	1.75	1.650
9	4.8 to 6.2	.031	2.00	1.580

[1] These cases are included in the 31 cases with range 0.4 to 1.2.

The relation between A_1 and the vapor pressure is a linear one for values of e less than 5.5 mm. For each decrease of one millimeter in the vapor pressure there is an increase of 0.044 calories in the value of A_1. The value of A_1 corresponding to zero vapor pressure is 1.800 calories. A plot of the above tabular values for the mean vapor pressure and the mean variability of A_1 shows that the relation between these two variables can be represented by a curve whose intersection with the axis at zero vapor pressure corresponds to a mean variability of ± 0.010 calories for A_1, or ± 0.56 per cent of 1.800. The approximate probable error is ± 0.35 per cent.

The La Quiaca data thus fully confirm the results from the four fragmentary series above cited. The probable error of the best observations at air mass 1 with vapor pressure averaging 0.5 mm. is about ± 0.40 per cent.

These high level observations, five independent series, were all made prior to 1914, and give *closely accordant results*, showing that at elevations of 3.5 to 4.5 km. on excellent days with vapor pressure averaging 1.5 mm. the probable error of the extrapolated intensity A_1 is about ± 0.40 per cent.

(*b*) *at Mount Wilson.*—A selection of 53 determinations of A_1 at Mount Wilson during the years 1910 to 1920, exclusive of 1912 and 1913, comprising all days with precipitable water 3.5 mm. or less, and of very good or excellent grade, yielded a mean variability of ± 0.98 per cent, a mean deviation of ± 0.80 per cent and a probable error of about ± 0.65 per cent. The mean variability of E_0 during these years was about ± 1.6 per cent, and the probable error about ± 1.1 per cent, or 0.60 per cent greater than that of A_1 on high grade days. These 53 selected days must be regarded as a random sample, and because of this the probable variation of true solar variation on these days should not differ much from the variation based on all days. This value of the probable error of A_1 on high grade days at Mount Wilson, is consistent with the value, one-third less, derived from stations at elevations of 3.5 to 4.5 km.

(*c*) *at Calama.*—The probable error of the values of A_1 at Calama during the years 1918 and 1919, grouped in accordance with amounts of precipitable water varying by half a millimeter, was ± 0.66 per cent for amounts of precipitable water averaging 1.0 mms., and increased to ± 0.74 per cent for amounts averaging 4.0 mm. During this time the probable error of E_0 was about ± 0.90 per cent. It is probable that the greater prevalence of dust at Calama was partly responsible for the increased amount of scatter there as compared with Mount Wilson.

The source and extent of the variations in A_1.—These may be summarized as (*a*) Solar variations. Small fluctuations are possible but not proved. (*b*) Atmospheric variations, caused by the absorption or scatter by the variable contents, aqueous vapor, ice crystals and dust. The amount of these variations decreases with increasing altitude. (*c*) Errors of observation, nearly constant at all altitudes. These include the error of extrapolation to air mass one, already discussed and the instrumental error. The probable error of a single observation by a copper-disk pyrheliometer is stated by Abbot (Annals Vol. IV, p. 162) to be ± 0.37 per cent, while for the silver-disk instrument the probable error is ± 0.20 per cent. This latter value is doubtless too low for observations under average observing conditions. The Mount Wilson observations were made with a copper-disk instrument, as were the early observations on Mount Whitney. Bigelow's observations in South America were made with a silver-disk instrument. Of the Ångström observations nothing is known beyond the determination of the probable error of the instruments read at Teneriffe in 1896, which, as stated above, was ± 0.41 per cent.

If the probable error of A_1 at 4 km. be regarded as ± 0.40 per cent, and the probable instrumental error be placed at ± 0.30 per cent, it is obvious that after allowance is made for residual atmospheric variations, and error of extrapolation, little is left for solar variation.

CONCLUSIONS

Summarizing the foregoing analyses, it is found (1) that the fluctuations of all day-to-day, and even monthly and yearly mean values of the solar constant are so unmistakably correlated with the transparency of the atmosphere, with its water vapor content and seasonal characteristics that they can not be regarded as even approximate values of real changes in solar intensity.

(2) That whether the comparison is made between measurements of intensities and their scatter, made at widely different times and at stations differing greatly in altitude and therefore in actual air mass, or between intensities, as if at air mass one, and their scatter, at different high-altitude stations where skies are clear and water vapor content nearly zero, we arrive at the one result, that day-to-day and other short-interval fluctuations become progressively smaller, the dryer, clearer, and lesser the air mass through which incoming radiation passes before reaching the measuring instruments.

All these results point to the conclusion that if one could but wholly remove the atmosphere with all its depletions and fluctuations of intensity of transmission, and all instrumental errors, scarcely any variations of radiation intensity would remain. The results are the more satisfactory because the data from whatever source tell the same consistent story, notwithstanding that the observations in some cases are few, made at widely different times, at widely separated stations, and by different observers using entirely different instruments.

If it be conceded that small solar changes amounting to perhaps one to two-tenths of one per cent (measured as a probable error) are possible, it still remains necessary to prove their existence. In the meantime, one can scarcely fail to be impressed with the evidence for the almost absolute constancy of solar radiation.

[8] It should be stated that a careful examination of the La Quiaca data show that a marked discontinuity in the value of A_1 occurred about the middle of May, for some unaccountable reason. The mean values of A_1 and e for the month ending the 16th was 1.687 calories and 1.8 respectively. For the remainder of the month the means were 1.760 and 1.7. Thus with a nearly constant vapor pressure the value of A_1 was higher by 0.07 cal. The two series were regarded as each homogeneous, but in computing the mean variability the discontinuity was allowed for by taking the weighted average of the separate mean variabilities of the two series.

TEMPERATURE AND HUMIDITY OF THE UPPER AIR AT SAN DIEGO, CALIF.

By Lieut. B. H. WYATT, U. S. Navy, San Diego, Calif.

Abstracted by L. T. Samuels

For the past three years the Naval Aerological Observatory at San Diego has been making free-air observations of temperature and humidity by means of airplanes. These observations were inaugurated primarily in order to determine densities aloft in connection with fleet target practice. It was soon decided, however, to continue the flights both for additional information with regard to the upper air and also to determine their value, if any, in relation to weather forecasting.

The instrument (aerograph) is suspended between the wings of a plane and a graphical record obtained of temperature, humidity, and pressure. In addition, notes are made upon general weather conditions as observed from the air, cloud altitudes, visibility, etc. Wind directions and velocities are determined from simultaneous pilot balloon observations. The average altitude reached has been between 6,000 and 8,000 feet. The following excerpts are quoted from Lieutenant Wyatt's paper:

Perhaps the outstanding feature of the records obtained, other than their apparent value in forecasting, is the great inversions of temperature found to exist on practically every day of the summer season and on numerous occasions during the so-called winter season. During the months of June, July, August, and September, 1924, every flight made, except one in the month of August, showed an inversion of temperature, the magnitude of the inversion varying between approximately 10° and 20° F. The inversions were usually found to begin at an altitude between 1,200 and 2,500 feet above the surface and to extend through a layer approximately 2,000 to 3,000 feet through. Practically every flight made during those months showed an increase in relative humidity from the surface up to the start of the inversion of temperature, after which it fell rapidly. At no time did the inversion extend above 6,000 feet, and temperature had usually started to fall before 5,000 feet had been attained. Pressure distribution during these months showed continuous low or relatively low pressure over the Colorado Basin, no map showing a pressure greater than 29.90 inches. Temperatures reported from this region of low pressure were above 100° F. Winds aloft over San Diego during the times of these flights invariably showed a layer of winds with an easterly component a few hundred meters above the surface, or else very light winds to calm.

It has been noted that very frequently the upper limit of haze or fog or cloud marks the start of the inversion, visibility usually being considerably improved through and above the inversion of temperature. Practically every flight that shows an inversion of temperature and an increase in humidity with a decrease above, was made at a time when the southwest semipermanent area of low pressure was well developed.

Other flights made show no inversion of temperature and a low relative humidity at the surface decreasing from the surface upward. It has been found that when these conditions are present, the pressure distribution shows that the weather is under the control of high pressure over the Southwestern States, and from the facts in the case this is what one would naturally suppose from the theory that the atmosphere in a high-pressure area is descending.[1] In the record of the flight for November 28, 1924, no inversion was encountered, both temperature and relative humidity decreasing from the surface to the limit of the flight. Pressure distribution on that date shows a HIGH centered over northern Nevada and southern Idaho, Boise reporting a barometer reading of 30.60 inches, and a relatively steep pressure gradient existing to the northeast of San Diego. The records showing these characteristics also fall into a definite class of pressure distribution.

[1] The latter half of this sentence was evidently written under misapprehension as to (1) the present view of the theory that the air in anticyclones is descending, and (2) the effect of a descent of air on its relative humidity.

(1) The idea is no longer held that there is an active descent of air in anticyclones except very locally along the fringes of the mass of cold air at the earth's surface, and even here the descent is through a small vertical extent. The great body of air settles with extreme slowness. Sir Napier Shaw has calculated the rate to be about 86 meters per day for the North Atlantic anticyclone, and for small anticyclones, 3 to 5 times as much. Hence as regards relative humidity changes, these must be controlled by factors other than adiabatic heating induced by descent.

(2) If anticyclonic air did actively descend, its relative humidity would decrease from top to bottom, not from bottom to top, obviously because adiabatic warming increases the capacity of air for water vapor.—B. M. V.

In another class are those records that show no inversion of temperature and either high relative humidity within the limits of the flight or an increase of humidity up to certain limits, and it is these records that have been of value in the forecasting of precipitation. The flight made on October 6, 1924, was the first flight made that showed these characteristics very definitely and precipitation occurred on the night of that date. The record of this flight shows that the sky was practically overcast with strato-cumulus clouds at an elevation of 5,000 feet. Temperature fell during the entire climb except when emerging through the cloud bank where a slight inversion occurred after which temperature continued to fall. Relative humidity increased from the surface upward except when passing through inversion of temperature. Pressure distribution on the morning of this date showed high pressure over the entire country east of the Rocky Mountains and a low pressure area centered at Tonopah, Nev., that station reporting a barometer reading of somewhat lower than 29.70 inches. During the night, the low-pressure area had moved somewhat to the southeastward and was centered at Flagstaff, Ariz., and the following morning relatively high pressure showed along the entire Pacific Coast.

The flight for December 17, 1924, shows no inversion and an increase in relative humidity with altitude and shortly thereafter precipitation occurred. Of 24 records showing these characteristics, 18 were followed by precipitation, usually occurring during the night following the flight.

Although there has been insufficient data collected upon which to form any definite conclusions, there seems to be no doubt of the value of the flights in regard to forecasting and it is hoped that with the additional collecting of data, many facts hitherto unknown will be made apparent and that knowledge of them will increase the percentage of verification of forecasting in this locality, particularly in regard to precipitation. Often when there has been a doubt as to whether to issue a rain or fair weather forecast, the writer has waited until after the aerographic flight was made and if the the record showed these characteristics, a rain forecast was issued and in only one case where the forecast was based upon the aerographic flight record was the forecast of precipitation a failure. During the month of February, 1924, when precipitation occurred on three successive nights with clearing weather during the day, the forecast of rain was issued solely upon the indications of the flight record and was verified 100 per cent for the storm.

DEVELOPMENT AND PRESENT STATUS OF FROST-FIGHTING DEVICES

By FLOYD D. YOUNG

[U. S. Weather Bureau, Los Angeles, Calif.]

Nearly nineteen hundred years ago the Romans were attempting to protect their vineyards from damage by frost by building smudge fires. This method is still in use in some parts of the United States, although careful experiments have demonstrated that a smoke cover alone affords little protection.

Apparently the first actual "orchard heating," as distinguished from "smudging," on the Pacific coast was carried on in orange groves near Riverside, Calif. during the years 1897–1899. Coal baskets made of large mesh heavy wire screen were set in the orchards at the rate of 40 baskets to the acre. Good results were obtained.

The use of oil-burning orchard heaters on a large scale appears to have begun about 1905. They were at first simply open pans, which gave off large quantities of black smoke and soot. Following the disastrous freeze in southern California in 1913, the "low-stack" oil heater came into more general use. The amount of smoke and soot was thus reduced somewhat, but combustion was still far from satisfactory.

Between 1915 and 1918 the so-called "high-stack" heater began to make its appearance. These heaters are more nearly smokeless than any other type that has been put on the market in commercial quantities. During a warm day, they will, with draft carefully regulated, burn with practically no smoke. But when hundreds or

thousands are burning together on a cold night, with little or no careful regulation, considerable smoke results.

In 1917, when the Weather Bureau fruit-frost service was begun, orchard heating was in bad repute, due to the use of poor equipment, too few heaters to the acre, inaccurate thermometers, over-sleeping, etc. The acreage protected with heaters was decreasing from year to year, and the smoke problem was not acute except in one or two localities. During recent years, however, the protected acreage has increased by leaps and bounds. During the winter of 1924–25, there was so much orchard heating that considerable objection to the smoke and soot resulted.

The townspeople in fruit growing communities have been looking for improved smokeless methods of protecting the fruit, but they have not been working alone. Orchard heating is an extremely disagreeable chore at best. The grower therefore has a double incentive to develop some new method of frost protection. This is as it should be, if it were not for the fact that both growers and townspeople have been so eager for a solution of the problem that they have grasped at straws. Every new scheme has immediately gathered a host of enthusiastic supporters.

It has been the policy of the fruit-frost service to test each new device for frost protection as soon as it has been placed on the market Tests are made in the orchards and only on frosty nights, so that the result will be conclusive. We then make public our findings through talks at fruit growers' meetings, magazine and newspaper articles, and by correspondence in reply to written requests for information.

Early in 1920 we published a short paper showing that temperature inversion on most frosty nights in southern California is very strong. Immediately several inventors set to work to devise machines to keep the air mixed to a considerable height above the ground and prevent stratification. The problem appeared so simple that growers easily were led to believe the extravagant claims made by the inventors and their salesmen.

The first machine tested was very crude. It consisted of a horizontal fan with four blades 6 feet in length, placed on the top of a 15-foot tower and turned at the rate of about 100 revolutions per minute by a gasoline motor, to force down the warmer air lying above the orchard. Later, orchard heaters were placed in a ring about the base of the tower to further heat the descending air. The machine was a complete failure.

The second machine consisted of a centrifugal blower, connected to a vertical pipe the upper end of which was about 15 feet above the ground. An elbow at this upper end turned the stream of air horizontally outward. By rotating the pipe the air was discharged in any direction desired. As was to be expected, this machine also failed to accomplish it purpose.

It would have been a simple matter to demonstrate theoretically that neither of these machines had any hope of success, but a thorough field test was necessary to convince the growers. In spite of the wide publicity given the results of these tests a stock company was organized to manufacture and market the first machine, and several machines of the second type were actually sold. Fortunately the following winter was unusually cold and the purchasers soon were convinced that they had been misled.

The third machine (fig. 3) was erected for experimental purposes in a lemon grove by an association of fruit growers. A 15-inch sheet-iron pipe was placed upright, with its upper end 35 feet above the ground. Near its base a 40-inch centrifugal blower operated by a 20-horse power gasoline motor drew air down through the pipe to two outlets, one of which discharged it downward against the ground, the other throwing a current horizontally over the tops of the trees. The two outlets were used independently at different times. Two small oil burners were connected with the vertical pipe, so that the heated gases were drawn directly into the blower and mixed with the air brought down from the 35-foot level.

Some very interesting results were obtained with this machine. Without the furnaces in operation the temperature of the discharged air averaged 6° to 7° higher than air at the same elevation in the orchard. With the furnaces the temperature at the outlet was about 35° higher than in the orchard. The volume of air discharged was too small, however, to affect the temperature in the orchard appreciably, and when the furnaces were operated the warm air passed upward so rapidly that it soon was lost. Also it was not possible to force the air stream more than a few feet against the natural drift in the orchard.

The fourth machine tested was constructed on a rather heroic scale. It was built entirely of steel, on a concrete foundation, and was equipped with a six-cylinder, 120 horsepower gasoline motor geared to a vertical shaft turning at 700 revolutions per minute a four-bladed airplane propeller 40 feet above the ground. A large oil-burning furnace was set between the propellor and the ground to heat the descending air from the propellor. Perforated water pipes furnished a spray with which it was intended to increase the humidity of the air as it was driven downward and outward by the machine. The furnace consumed 80 gallons of fuel oil per hour, and the motor 10 gallons of gasoline.

The machine was set up in an orange grove of large and heavily foliaged trees. On the night of the most favorable test, the temperature was 30.1° in the orchard, and 36.6° at the edge of the apron below the propeller without the furnace being operated. The velocity of the air at this point was so great that it was practically impossible to breath. But there was no visible evidence of air movement farther than 120 feet to the northward. Toward the west, in the general direction of the natural air drift, the movement could be noted somewhat farther, but the effect on temperature was slight at a distance of more than 125 feet. The temperature 50 feet west of the machine was raised 5° without the furnace in operation, and 8° with the furnace. The failure of the machine was due to its inability to spread the heated air over a large enough area.

The fifth and latest "wind-jammer," (fig. 3) as these machines are called locally, is backed by almost unlimited capital. Some of the best known capitalists in California are said to be heavily interested in the corporation. The machine consists of a large diameter pipe in the form of a right angle, with the bottom of the vertical portion about 25 feet above the Ground, supported by an open framework. Below the lower end of the pipe is a large oil-burning furnace. A propeller set between the furnace and the pipe forces the products of combustion into the lower end of the pipe from the upper end of which they are discharged horizontally over the tops of of the trees at a height of about 35 feet above the ground. One machine is guaranteed by the manufacturers to furnish adequate protection for 10 acres. The first machine tested failed mechanically. Its effect on the temperature was negligible.

An all metal machine with a minimum number of parts was then designed, and a number of them were sold before they could be thoroughly tested. During the cold

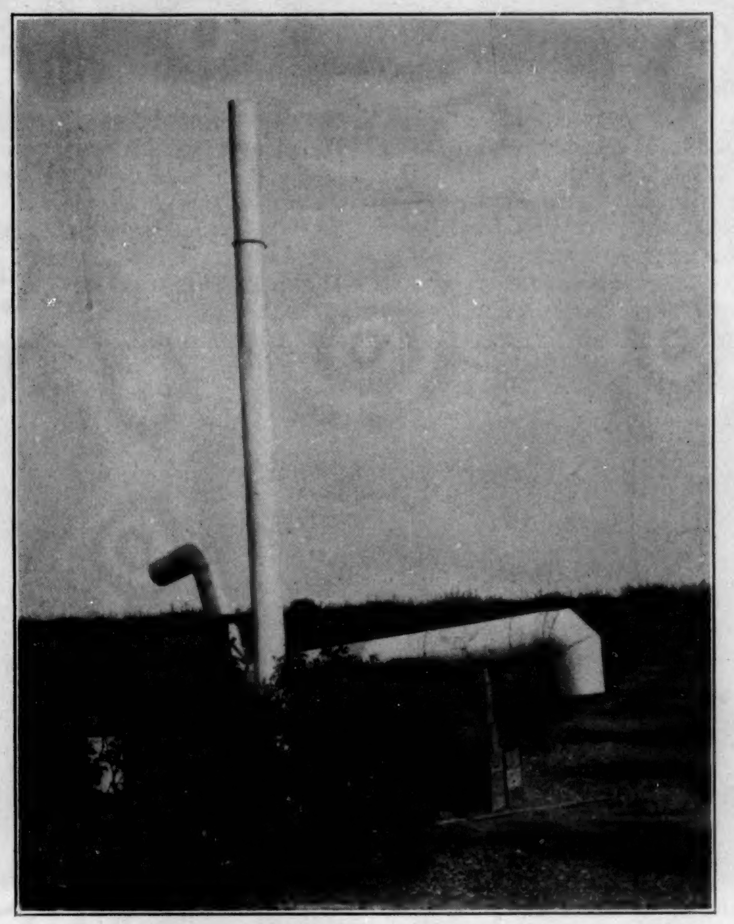

FIG. 1.—Machine developed to bring down warm air from above the orchards on frosty nights for distribution among the trees. Vertical galvanized sheet-iron pipe, 15 inches in diameter and 35 feet high

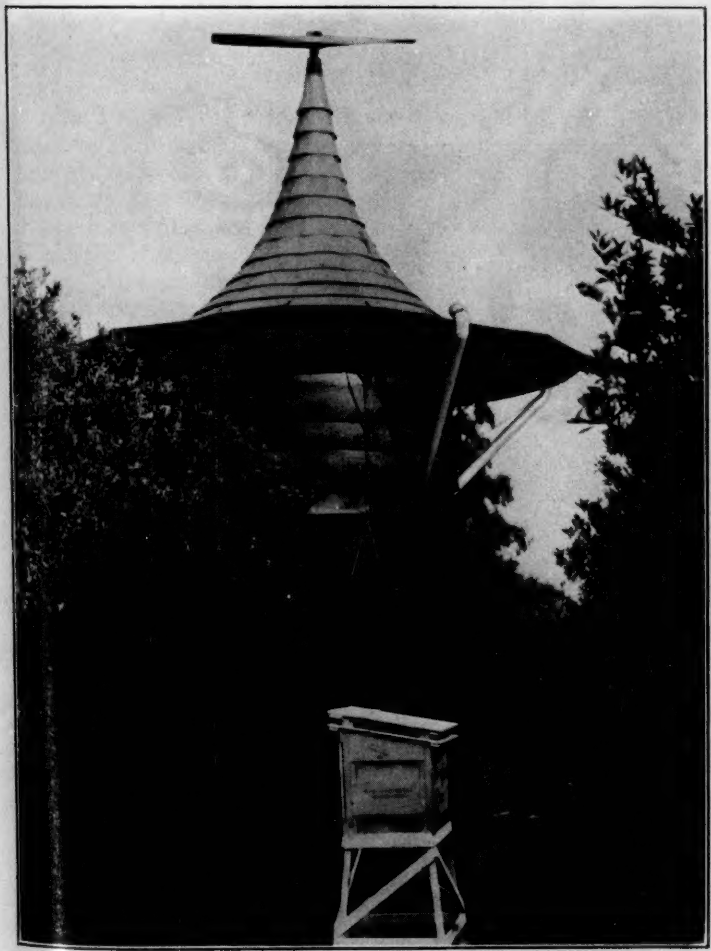

FIG. 2.—In this machine the airplane propeller, intended to bring down warm air from above the trees, is 40 feet above the ground. The "barrel" of the machine, below the roof, contains an oil-burning furnace, which heats the descending air

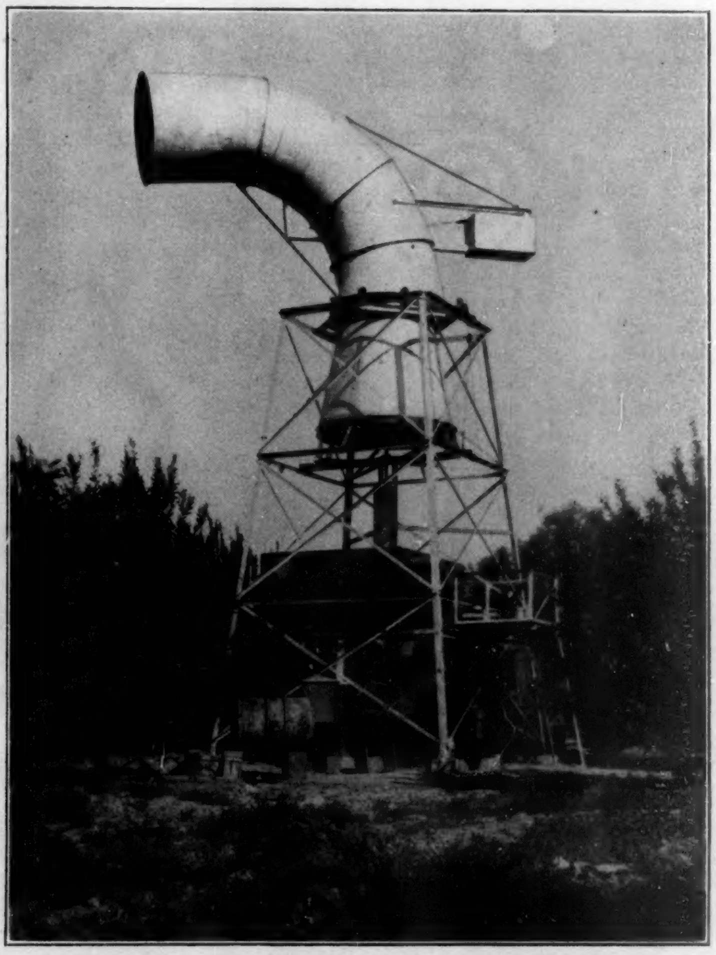

FIG. 3.—Latest type of machine designed to mix air strata on frosty nights, and thus to raise the temperature. An airplane propeller directly below the lower end of the large pipe throws a stream of air upward through it. An oil-burning furnace heats the air before it reaches the propeller. The discharge outlet of the pipe is about 35 feet above the ground

FIG. 1.—Lard-pail oil-burning heaters set on metal stands in cranberry bog near Seaview, Wash. The heaters are used in the spring to protect the blossoms and buds from damage by frost, and in the fall to protect the berries

FIG. 2.—Close-up view of heater on metal stand in cranberry bog. The three legs of the stand are forced into the ground several inches, so that the strong winds which sometimes blow in the district can not overturn tne heaters

periods of December, 1924, two of these machines were given a careful test in a lemon grove near Pasadena, Calif. One broke down immediately because of the settling of the motor. The other was kept running only with difficulty, because of overheating of the motor, but it was operated throughout all the cold nights. It showed practically no effect whatever on the temperature in the orchard, even within a few feet of the base of the machine.

Following the earlier tests, which showed that the temperature in the orchard was not raised appreciably, the officials of the company had claimed that protection against freezing of the fruit was afforded regardless of temperature simply by creating a breeze over the trees. In the latest test, however, this contention was entirely disproved. The fruit crop was a total loss, and the trees were defoliated and severely damaged.

This corporation has spent probably several hundred thousand dollars in experimental work, without much encouragement. At present it appears that the method will be abandoned. The machines cost several thousand dollars each, and it is believed that by discouraging their purchase the Weather Bureau has been instrumental in saving the growers large sums of money.

Overhead sprinklers.—During the past two years several citrus growers have installed overhead sprinklers, for irrigation and frost fighting combined. Vertical pipes carrying the sprinklers at their tops are set at intervals which allow the entire grove to be sprayed.

From the beginning, we have done everything possible to prevent growers from counting on the efficiency of overhead sprinklers in protecting fruit from frost. Despite this, several large citrus groves were equipped with them, mainly for frost protection.

During the winter of 1924–25 a careful check on the effect of this artificial rain was made under actual frost conditions. The temperature was raised about 3°, but it was necessary to shut off the water after about two hours, because the heavy coating of ice threatened to strip the branches from the trees. We have thus been able to convince the growers that overhead irrigation for this purpose is not practical.

To describe all the new heaters tested would exceed the limits set for this paper. They may be briefly mentioned. First is the central heating plant. The fuel was burned in a large furnace, and the heated gases driven through large pipes through the orchard. Second is the covering of the trees with canvas tents. Third is the running of irrigation water in furrows in the orchard; this practice appears to have some value, but is effective only when the temperature does not fall much below the danger point. In a carefully conducted experiment, it was found that running water at a temperature of 72° in an orange grove held the temperature about 1.5° on the average above the outside temperature. Fourth is the use of coal briquets for orchard heater fuel. These were found to be satisfactory for protecting small acreages, but high labor charges and other drawbacks make their use inadvisable for large acreages.

To sum up the matter, the orchard heater is today the only practical means of obtaining complete protection from low temperatures in orchards, but constant effort is being directed toward finding some more satisfactory method.

VALUE OF SMUDGE-POTS IN PREVENTING FROST IN CRANBERRY BOGS

(Summary of a report by R. A. Wells and Perry Parker)

By FLOYD D. YOUNG

The Fruit-Frost Service of the Weather Bureau receives numerous inquiries regarding the practicability of using heaters to protect low-growing crops, such as strawberries, potatoes and tomatoes, from frost damage. Tests conducted recently by Mr. Roy A. Wells, in charge of the Weather Bureau office at North Head, Wash., and Mr. Perry Parker, his assistant, to determine the amount of the temperature rise that can be obtained by burning fuel oil in lard-pail heaters on the cranberry bogs near the mouth of the Columbia River, are of considerable interest in this connection. The flooding of the bogs for frost protection, as is done in Wisconsin and the Atlantic coast cranberry sections, is not practicable in Washington.

A one-half acre plot, equipped with forty 10-quart lard-pail oil heaters, was selected for the heating tests. The heaters are similar in shape to an ordinary lard pail, from which they take their name. They are 9 inches in height, with a top 9½ inches in diameter, and a bottom 8½ inches in diameter. The "spider" is a removable disk, which is placed over the top of the heater, reducing the rate of fuel consumption.

An instrument shelter was placed in the center of the plot, and another in a bog not equipped with heaters, about 300 feet distant, for a check on the outside temperature. Both shelters were set directly on the vines. The instrument shelter in the protected area was placed 15 feet from the nearest heater. Exposed thermometers were placed on the surface of the vines near both instrument shelters, for a check on the radiation temperature.

The heaters were lighted on two frosty nights, September 25–26, and October 10–11, 1924. On both nights a ground fog hung over the check plot at intervals, but no fog formed over the heated plot. During the first experiment the heaters were set on iron tripods, of the type shown in Figure 1, with the tops of the heaters 2½ feet above the surface of the vines. The heaters were burned with the so-called "soot arresters" or "spiders" in place, reducing the rate of burning about two-thirds. The maximum rise in temperature inside the instrument shelter, due to the heaters, was 2.9° F. The ground fog at the check station affected the temperature indicated by the thermometer exposed on the surface of the vines, so that a direct comparison between the exposed thermometer readings at the two plots can not be made. However, by comparing the difference between the readings of the sheltered and exposed thermometers in the area equipped with heaters before the heaters were lighted, with the difference while the heaters were burning, some conception of the effect of the direct radiation from the heaters on the temperature of the vines, may be obtained.

Before the heaters were lighted the average difference between the readings of the sheltered and exposed thermometers was 5.1° F. When the heaters were lighted the difference was reduced to 1.4° F., making a rise of 3.7° F. due to the heating. Adding the rise of 2.9° F. shown by the sheltered thermometer, to the 3.7° F. rise shown by the unsheltered thermometer, due to direct radiation from the heaters, a maximum effective rise in temperature at the surface of the vines of 6.6° F. is indicated. The average effective rise in temperature on this night was 5.1° F. at the surface of the vines.

When the heaters burned out in the morning there was a dry area about 4 feet in diameter and a frost-free area about 8 feet in diameter, around each heater.

On the second night the heaters were set directly on the surface of the cranberry vines. The "soot arresters" were removed after the heaters had been burning one hour, increasing the rate at which fuel was consumed about three times. After an hour of burning at this rate, the dry area around the heaters was about 6 feet in diameter, and the frost-free area about 10 feet in diameter. An inverted cone, 2 feet in diameter, placed directly over one of the heaters, increased, the diameter of the dry area to 8 feet, and the frost-free area to 12 feet.

The vines in a very small area around the heaters were scorched when the heaters were set directly on the surface of the vines. There was no scorching when the heaters were burned on the tripods. The effective rise in temperature at the surface of the vines, as shown by exposed thermometers laid directly on the vines, averaged 3.6° F. on the second night. The smaller rise was probably due largely to the flame from the heaters being closer to the ground.

The average gain in temperature on the two nights, due to the use of the heaters, was 1.7° F. inside the instrument shelter, and 4° F. on the surface of the vines.

The frost on the two nights of the test caused about 15 per cent damage in the check plot. There was no damage in the plot equipped with heaters.

The fuel oil burned in the heaters cost 6 cents per gallon in barrel lots. The cost of the oil burned was 96 cents per acre per hour with the soot arresters in place, and $3 per acre per hour without them.

The experiments conducted by Messrs. Wells and Parker indicate that it is practicable to protect cranberries from frost damage by the use of orchard heaters, at a reasonable cost. It is believed that as good or better results can be secured in protecting other low-growing crops, using the same methods.

SAMPLING THE HIGHER ATMOSPHERE

By W. J. HUMPHREYS

It seems practically certain that the percentages of the several gases of the atmosphere, except water vapor, are very nearly constant from the surface of the earth up to the base of the stratosphere, that is, throughout the layer of considerable convectional mixing. In the stratosphere, however, where convection exists only feebly if at all, and each gas therefore is distributed substantially as it would be if it alone were present, these percentages presumably vary with height, those of the heavier constituents decreasing and those of the lighter increasing.

If this be the actual condition of the stratosphere, as seems highly probable, then the composition and density of the atmosphere at any level in this region readily could be computed if we knew the temperature distribution below that point. Now, the average temperature of the air at every level, from the surface of the earth up to the height of at least 30 kilometers, is well known, season by season, for many places. In the middle latitudes, for instance, the temperature of the air from the height of about 11 kilometers up as far as explored, 30 to 35 kilometers, is around −55° C., varying slightly with the seasons and with the weather in the lower atmosphere. What the temperature, hence also the density, and even the composition, of the air is beyond the levels explored by the registering instruments carried by sounding balloons no one really knows. This temperature may remain substantially constant to the limit of the atmosphere of measurable density. Many have assumed it to do so as the result of a flux of outgoing radiation, practically invariable with height. On the other hand Vegard [1], at least, has argued from his studies of the aurora, that the temperature of the very high atmosphere, 100 kilometers, and up, above the surface, must be more or less below that of melting nitrogen, or, say −225° C.; and, furthermore, that the higher portions of the atmosphere contain neither helium nor hydrogen, but consist of nitrogen only, chiefly in the form of crystals held up by their state of electrification. Finally, Lindemann and Dobson [2] conclude from their study of meteor data that the temperature of the outer air, 40 to 50 kilometers and beyond, is in the neighborhood of 30° C.—tropical heat.

Here then was confusion which, though theory might greatly reduce, only direct observations, perhaps, could fully remove. This confusion remained as bad as ever until near the middle of 1924, since when it has so greatly yielded as now to be much less pronounced and provoking.

Free hydrogen might, of course, be present in the lower portions of the atmosphere and not in its outermost layers, owing partly, at least, to the presence of ozone, which might oxidize the hydrogen to water vapor, somewhere in the upper air. However, no similar argument applies to helium.

McLennan [3] has shown that the green fluorescent lines of solid nitrogen, produced by electron bombardment, do not coincide with auroral lines, and in particular that, "the" auroral line, λ 5577.35, is not so produced, contrary to Vegard's original belief that it was. Furthermore, McLennan and Shrum [4] have shown that this line is produced by an electric discharge through a mixture of air and helium, or oxygen and helium, at low temperature, also at room temperature, and low pressure. Hence the assumptions that there is helium in the upper levels of the atmosphere, and that the temperature of this region is above that of frozen nitrogen, are not only restored to reasonableness, but raised well nigh to certainties.

The logic of Lindemann and Dobson for a high temperature of the atmosphere at the 40 to 50 kilometer level and beyond, also has been questioned. A different line of attack from theirs by Sparrow [5] of the problem of meteor luminescence seems to remove the apparent necessity for any higher temperature in the outer reaches of the atmosphere than that measured hundreds of times and known to obtain at every level from, say, 12 to 30 kilometers.

Perhaps, then, the other horn of our upper air dilemma also is removed. If so it again would seem reasonable to assume that the outer air contains helium, and possibly hydrogen, and that its temperature in middle latitudes is around −55° C.

But however reasonable these assumptions may be they are not known facts. We do not know certainly either the average temperature or the composition of the air beyond levels reached by sounding balloons. This ignorance about the state and condition of our atmosphere is reason enough why we should try to ascertain

[1] Phil. Mag., 46, p. 577, 1923.
[2] Proc. Roy. Soc., A, 102, 411, 1923; 103, 339, 1923.
[3] Toronto meeting of the British Association for the Advancement of Science; and elsewhere.
[4] Proc. Roy. Soc., A, 108, 501, 1925.
[5] To be printed in an early issue of the Astrophysical Journal.

the facts. Besides, the truth in these particulars would aid in the solution of a host of other problems.

There is, then, ample reason for trying to measure the temperature and determine the composition of the outer and as yet unexplored portions of our atmosphere.

A possible general scheme, the details of which might vary greatly, for obtaining these data is as follows:

1. The height will be attained by means of a rocket of the type, say, now being developed by Professor Goddard of Clark University.

2. A highly exhausted, thin-walled, and hermetically sealed tube is carried on or in the head of the rocket.

3. This tube is surrounded by water and a little ice, and the containing vessel more or less thermally insulated from the adjacent air—suggested by a constant temperature device used with balloon pyrheliometers by Abbot, Fowle, and Aldrich.[6]

4. At about the top of the flight the drawn-out tip of the exhausted tube is broken off near its end by a device actuated by the exhaustion of the rocket propellant, or otherwise, as may seem best.

5. As soon as the tube has filled—that is, in a second or two after it was opened, and actuated by the equilibrium between internal and external pressure thus obtained, or otherwise—the tube is again hermetically sealed. This can be done by the short-circuiting of a minute electric cell through a fine platinum wire wound around the drawn-out neck.

The last two suggestions, (4) and (5), are taken from the method successfully used by Teisserenc de Bort in getting samples of air with sounding balloons.

6. At the time the tube is being filled, a flash light of the kind (there are such) that will operate in air of any pressure, however low, is fired. This presupposes that the air catch is to be made on cloudless nights during the dark of the moon.

7. At two or more suitable stations the flash is photographed amidst the stars with appropriate cameras. This gives, very approximately, the level at which the sample of air was obtained, and is the same scheme as that used by Störmer and others for measuring the heights of auroras.

If all has gone according to plan, and the tube, let down by parachute, or otherwise protected, has been found, we now have a sample of the air taken in at a known height and known temperature, 0° C. (as secured by the ice and water-jacketing of the sampling tube), whatever the surrounding temperature, but unknown pressure. Obviously, however, this pressure, the pressure of the entrapped gas when at 0° C., can be measured at leisure in the laboratory. Furthermore, the constituents of the sample of air, and their relative amounts, are matters of gas analysis of any desired refinement.

A series of such samplings, made at height intervals of 5 to 10 kilometers, would give us the approximate composition of the atmosphere and its pressure at each of various known heights. From these data in turn the corresponding temperatures could be closely computed, since only one distribution of temperature could give, with the known gases, the particular pressures thus found, assuming, of course, that, as shown by Atkinson [7] the pressure of the atmosphere at all levels is essentially of gravitational origin and not appreciably affected by electrification.

Evidently, the observations suggested above would require skill and ingenuity, but they clearly are possible and the facts to be learned highly desirable.

PAPERS READ AT THE PORTLAND, OREG., MEETING OF THE AMERICAN METEOROLOGICAL SOCIETY, JUNE 18, 1925

(For other papers presented at the same meeting, see the Bulletin of the American Meteorological Society)

WIDE AREA FORECASTING OF STREAMFLOW ON THE COLUMBIA AND COLORADO

By J. E. CHURCH, Director

[Mount Rose Observatory, Reno, Nevada]

West of the Great Continental Divide the United States lives and has its being in its streams.

Three watersheds or series of river systems, arranged in combination like a gothic A, serve this vast region. Dividing between them 1,600 miles of the western apex of the Continental Divide, the Columbia and Colorado flow westward through tributary regions of 237,000 and 225,000 square miles, respectively, to the sea. Connecting them and forming the crossbar of the A, is the Sierra Nevada system furrowed by streams of lesser length but whose combined output exceeds by nearly twice the output of the Colorado.

Contrary to expectation, the relative flow from these three watersheds is Colorado 1, Sierra Nevada 2, Columbia 9, or an annual run-off from the Colorado of 17,500,000 acre-feet, from the Sierra Nevada approximately 32,500,000 acre-feet, and from the Columbia 151,700,000 acre-feet.

Upon the impounding and distribution of these life streams depend the growth and prosperity of the Pacific coast. As a basic factor in their control and maximum use, the Mount Rose Observatory with cooperation from the U. S. Weather Bureau has devoted its energies during the past decade and a half to investigating the possibility of forecasting the seasonal run-off from the streams in the Sierra Nevada and ultimately from the Columbia and Colorado as well.

The possibility of wide-area snow surveying and close forecasting of the subsequent run-off has now been so thoroughly established in the central Sierra Nevada that the city of Los Angeles has adopted the method for its aqueduct in the Owens Basin and for its power projects elsewhere in the Southern Sierra. Through this action of Los Angeles opportunity will soon be afforded to test the system under extreme conditions of altitude and run-off.

Detailed investigation of the Columbia and Colorado watersheds has revealed the fact that despite their immense areas satisfactory snow surveys and forecasts can be established for each at no greater difficulty and expense than for the joint streams of the central Sierra Nevada. The only new element involved is the higher relative precipitation in summer on the Continental Divide which may affect the run-off beyond the indications of the snow survey and early rains.

The simplicity of the problem is based upon the following peculiarities:

Despite the apparent vast area of their watersheds, these streams are fed in large part by three main feeders that supply from 77 to to 87.1 per cent of their total annual flow. Furthermore, the flow in the main stream, based, however, upon short records only, varies less than 11 per cent from the combined flow of the feeders and the extreme variation between even one feeder and the main stream, over a long term of years, has not exceeded 25 per cent. Finally, from 61 to 64 per cent of the entire annual flow occurs during the four months of April-July, due to the fact that the major supply comes from winter snows, which do not begin to melt until late in March. Therefore, a few snow surveys well placed on these main feeders should indicate the amount of water available for the season's crops and industrial needs.

Furthermore, they will indicate the danger of spring floods from the upper streams and in case the reservoirs are maintained at maximum level, as must be the case when the water is put to maximum use, the reservoirs can be eased down to prepare storage for flood waters rather than permit the streams to flow full volume over the crests and menace the lands along the lower stream.

Fortunately, the winter floods that traverse western Oregon and Washington come mainly from the Cascades and find ready escape in the huge channel of the Columbia, which in the winter flows only at minimum stage because of the dormant snows on its main watershed.

[6] Smithsonian Miscellaneous Collections, Vol. 65, No. 4, 1915

[7] Proc. Roy. Soc., A 106, 429, 1924.

The future promise of the Columbia Basin, even now called the Inland Empire, when its waters are assigned their full duty, is best expressed in terms of the run-off of its three tributaries: Upper Columbia or Kootenay, 53,000,000 acre-feet; Pend Oreille, already center of a wide project, 19,000,000 acre-feet; and Snake, 45,000,000 acre-feet. But the presence of volcanic soil makes this promise larger, for even at low stages the net recovery on the Snake, after practically the entire flow has been used four times, is still 39 per cent.

The problem of building up the lesser but warmer Colorado Basin is even now at the door, and the equitable division of the water before it passes down the stream will underlie the development of seven States. The Green will furnish 5,700,000 acre-feet, the Grand 7,500,000 acre-feet, and the San Juan 3,100,000 acre-feet. The tiny Gila will furnish only 1,000,000 acre-feet, and of this only 159,000 acre-feet flows in April–July, when the need is greatest.

However, from this and other small additions, must be deducted 1,800,000 acre-feet, much of which apparently sinks in the delta above Yuma and seeps slowly to the Gulf. The problem of reclaiming this underground flow by artificial dikes will depend upon the relative value of the completed work.

THE CLIMATE OF BRITISH COLUMBIA

By F. NAPIER DENISON

[Meteorological Office, Victoria, B. C.]

Owing to the mountainous character of portions of this Province, its climate varies greatly according to local physical conditions.

The heaviest precipitation occurs on the western slopes of the Coast Ranges, the lightest between the coast and Selkirks, and increases eastward to the Rockies. The heaviest precipitation amounts to 120 inches on the west coast of Vancouver Island, about 180 inches on the high levels to the eastward of the city of Vancouver, while the wettest area on our coast is in the vicinity of Swanson Bay, near Princess Royal Island. Owing to the less mountainous character of the Queen Charlotte Islands as compared with Vancouver Island, the precipitation there is lighter, amounting to about 100 inches on the west coast and 50 inches on the eastern side.

Between the Coast and the Selkirk Ranges much of the southern area is termed the "dry belt," while extending northward between these ranges, which decrease in altitude, the Pacific Ocean LOWS spread inland and sufficient precipitation occurs for general vegetation. Further eastward climatic conditions become decidedly local throughout the Selkirk and Rocky Mountains.

The following table gives the average annual precipitation for certain typical stations, extending from the west coast to the Rockies across both southern and northern British Columbia. The elevations are also given.

TABLE 1.—*Average precipitation and elevation of certain British Columbia stations*

Station	Elevation	Precipitation
Southern group	*Feet*	*Inches*
Clayoquot	27	119.13
Nanaimo	125	37.46
Victoria	230	27.65
Vancouver	136	58.76
Kamloops	1,262	10.08
Penticton	1,200	11.21
Nelson	2,230	26.86
Invermere	2,650	11.47
Northern group		
Masset Q. C. I.	10	53.90
Prince Rupert	170	101.74
Prince George	1,867	18.11
Fort St. James	2,280	15.75
Barkerville	4,180	36.63
Glacier	4,072	60.24

Even at the low level of 27 feet on the western coast of Vancouver Island the precipitation is 119 inches, while in crossing the island to Nanaimo the yearly total drops to 37 inches, and at the southeastern part of the island about Victoria it is only 27.65 inches. The influence of the mainland coast mountains is clearly seen by the marked rise to 58 inches at Vancouver, while Kamloops and Penticton in the "dry belt," where irrigation has made a wonderful fruit-growing district, only 10 and 11 inches, respectively, is the annual amount. At the higher elevation at Nelson in Kootenai the precipitation rises again to 27 inches.

Crossing the northern part of the Province, Masset on the east coast of the Queen Charlotte Islands has 54 inches and Prince Rupert on the north coast mainland 102 inches, while east of the coast mountains the northern interior has from 6 to 8 inches more precipitation than in the southern interior, already mentioned. Barkerville in Caribou and Glacier in the Rockies are given to show the increased precipitation at stations over 4,000 feet.

In connection with heavy precipitation in this Province, it appears that at Henderson Lake on the west coast of Vancouver Island, where we now have a station, the annual precipitation was 228 inches in 1923, with 79 inches in December, and in 1924 the yearly total was 281 inches. It is probable that owing to peculiar local conditions this station may prove to be the wettest spot not only in this Province but on the North Pacific coast.

Mean temperature and bright sunshine.—In the following table the mean temperature is shown for the coldest and warmest months of the year, together with the annual amount of bright sunshine, for certain typical stations, including Edmonton, Alberta, for purposes of comparison.

TABLE 2.—*Mean temperature and bright sunshine*

Station	January	July	Range	Annual hours sunshine
	°F.	°F.	°F.	
Victoria	39	60	21	2,163
Nanaimo	36	63	27	1,898
Prince Rupert	32	57	25	1,214
Vancouver	36	63	27	1,829
Kamloops	22	69	47	2,118
Vernon	21	66	45	2,089
Summerland	22	68	46	2,034
Nelson	25	66	41	1,895
Grand Forks	20	69	49	----------
Invermere	13	63	50	1,994
Cranbrook	17	62	45	----------
Edmonton, Alberta	6	61	55	2,137

In connection with these figures one is struck by the remarkably small seasonal range of temperature and large amount of sunshine as shown at Victoria. These conditions are due to the open nature of the land about there, and the moderating influence of the ever-changing tidal waters which almost surround that portion of Vancouver Island affect the temperature.

The seasonal range of temperature increases eastward to the dry belt and where the annual amount of bright sunshine is naturally high, yet still less than at Victoria.

The temperature extremes are greatest in Kootenai in the list of stations. A comparison shows that the southeastern portion of Vancouver Island records more bright sunshine than even parts of "Sunny Alberta."

THE CLIMATE OF OREGON DURING THE PLEISTOCENE PERIOD

By EDWIN T. HODGE, Professor of Geology

[University of Oregon]

(Author's Abstract)

Previous studies of the Pleistocene of British Columbia, Washington, and Oregon have brought out two statements regarding the climate of that time. They state that "the temperature gradually grew colder and finally culminated in the development of glaciers" and that a great sound occupying the Willamette Valley was developed at the close of the Pleistocene. This latter statement, if true, would likewise indicate a colder climate. The presence of a large body of water, in contrast to an equivalent land surface, reflects most of the light energy received, its latent heat is high, and evaporation from whatever cause results in cooling.

As a result of studies extended over the past eight years I have arrived at conclusions which materially differ from those hitherto published regarding geological events of the Pleistocene period of Oregon and Washington. These conclusions will be published elsewhere. If my theory regarding the events of the Pleistocene are correct, then the following deductions may be made regarding Pleistocene climate:

The period was introduced by the Pliocene uplift. This uplift continued into the Admiralty epoch, which brought the Coast Range and Cascades to an elevation whereby they intercepted a large part of the moist winds coming from the Pacific Ocean. The moist winds during most of the Pliocene were able to pass over the low mountains and fed large lakes in eastern Oregon, Washington, and California. The increment in the precipitation, due to the elevation along this coast, in the less-favored localities amounts to

more than 1 inch per each 100 feet. Because of the elevation and winter precipitation most of the water fell in the form of snow, and glaciers were developed. This robbing of the winds of their moisture by the Coast and Cascade Ranges dried up the lakes of eastern Oregon. Glaciers developed in this manner would not result in a reduction in the average temperature of western Oregon. On the contrary, these winds would contribute to Oregon the heat which they obtained from the warm Pacific. The moisture condensing to clouds and the cloud particles crystallizing to snow would cause these winds to give up their heat as a direct contribution to Oregon. The temperature undoubtedly was higher rather than lower. The above explanation involves no change in world climate, nor change in direction of wind, nor change in moisture content of the winds.

In the Puyallup epoch there was a subsidence of over 1,000 feet, which reduced the mountain crests to one lower than that of the present time. The moist westerly winds again were able to pass over western Oregon retaining much of their moisture which was precipitated in eastern Oregon, producing large lakes.

In the Vashon epoch elevation again took place, resulting in a second period of glaciation and the drying up of the lakes in eastern Oregon. At the close of the Vashon epoch there has been a subsidence resulting in the drowning of most of the river valleys of the Pacific Northwest. This subsidence, however, was not equal to that of the Puyallup epoch and consequently no great lakes have been developed.

Thus there were two uplifts and two glacial periods in Admiralty and Vashon time. Waters derived from their glaciers cut large valleys in western Oregon and on the flanks of the Cascades in eastern Oregon. There were two lake stages, one in pre-Admiralty and one in the Puyallup. The lakes of this second period have been drying up since that time. During the Puyallup period, and while the Admiralty glaciers were melting, aggradation on a large scale filled the Willamette Valley with sediments to an elevation of about 600 feet in the vicinity of Portland and about 150 feet in the vicinity of Eugene.

Further evidence that the climate was warm and that no chilling bodies of water existed is shown by the entire absence of marine fossils and by the presence of fossils of plants and animals requiring a warm climate. In western Oregon many fossil remains of the mammoth, mastadon, giant sloth, camel, and horse have been found. Fossil remains of the walnut, oak, willow, and sequoia have been found. The sequoia is apparently the same as the living sequoia in California at the present time and the oak and walnut are closely related to living species. These creatures could not have lived in Oregon had the climate been cold and would have been driven out if the valley had been occupied by a great sound. The glacial débris found in the Willamette Valley represent iceborne fragments which floated down the Willamette Valley while the valley was flooded by river waters in the Puyallup epoch.

This interpretation of the geology makes it possible for men to have migrated down the Pacific coast under favorable conditions and to have lived in the Willamette Valley during the glacial period. Fossil remains of a race of men antecedent to the Indians, which the white men found in this valley, have been found under conditions which would indicate that man was here during the Puyallup Epoch.

VARIABILITY OF PRECIPITATION IN THE STATE OF WASHINGTON

By M. B. SUMMERS

[Weather Bureau, Seattle, Wash.]

(Abstract)

The average precipitation in the State of Washington for individual months has varied between a trace and about 400 per cent of the mean of 35 years of record. The greatest variance occurs in the summer months and the most frequent variance in the region of the Cascades. In general, the greatest amount that has been received in any 12 consecutive months has been about double that of the driest similar period in the western division, and about three times the driest period in the eastern division. A singular feature of the variability in the eastern division is the fact that the July rainfall is above 150 per cent of the mean in about one year in three, and less than 50 per cent of the mean in about one year in three.

A rather rhythmic fluctuation in the precipitation curve is apparent from 1900 to 1907, with an average period of about 18 months.

FLOODS IN THE WILLAMETTE RIVER

By EDWARD LANSING WELLS

[U. S. Weather Bureau, Portland, Oreg.]

(Author's abstract)

This paper outlines problems connected with the forecasting of floods in the Willamette River.

The drainage basin has an area of approximately 11,000 square miles, varying greatly in surface and exposure, rising from near sea level to more than 10,000 feet.

The climate is mild and equable, with precipitation ranging from 38 inches to more than 100 inches, and averaging about 65 inches. The precipitation is distinctly seasonal.

There are 12 important tributaries, and there is no stretch of more than 50 miles without the entrance of one or more of these.

Rating tables form the best basis for relating stages at successive stations, but these are not available for all stations.

The river changes character as it drops over the falls at Oregon City, becoming, in a sense, an arm of the sea.

The difference between crest stages at Salem and Portland is greater in extreme floods than in ordinary floods, and is greater when the Columbia is low, but this relation is not constant.

Rises often begin at Portland almost as soon as at upstream stations.

NOTES, ABSTRACTS, AND REVIEWS

EVAPORATION MEASUREMENTS IN THE SWISS ALPS

J. Maurer and Otto Lütschg in Meteorologische Zeitschrift for March, 1925, pp. 111–114, summarize their results as attained thus far. Preliminary investigations were made in 1911–12, the results being published in Meteorologische Zeitschrift, 1911, no. 12, and 1913, no. 5. In the summer of 1915, with the physical and financial resources of the Swiss Federal Bureau of Water Control at their service, intensive studies were begun.

These were carried on at first with open circular vessels of sheet zinc (evaporation pans) of 30 and 50 cm. diameter and depth, respectively, supplemented by Livingston porous cup atmometers and glass vessels of 24 and 28 cm. diameter and 8 cm. depth, in the upper Saas Valley at the various altitudes indicated for the stations for which data are plotted in Figure 1, these data representing conditions in 1920. Evaporation measurements were always accompanied by observations of the meteorological elements. Evaporation pan measurements were carried out on Lake Mattmark, at about 2,100 meters above sea level, during the summers of 1915 and 1916. The summer of 1915 gave 24-hour evaporation values ranging between 6.2 mm. and 2 mm., according to the weather. The maximum value represents a warm and entirely clear period with light north wind. In 1916 the July and August 24-hour values ranged from 1.6 mm. and 3.4 mm.

The principal series of observations was made at the Hopschensee, 2,017 m. above sea level, west of the Simplon Pass, between July 25 and October 23, 1921. These were carried through by means of hydrometrical methods, taking account of the inflow and outflow and direct precipitation which affected the level of the lake. Coincident with these, a series of porous cup atmometer and glass vessel determinations was made in the meadow directly on the lake shore, the corresponding meteorological observations being taken also.

Table 1 for the Hopschensee summarizes evaporation from this lake by certain calendar groups of days without regard to weather conditions. Table 1a for the same lake divides the data for the same total period into groups according to weather type, a much more significant procedure. Table 2 summarizes the results obtained by

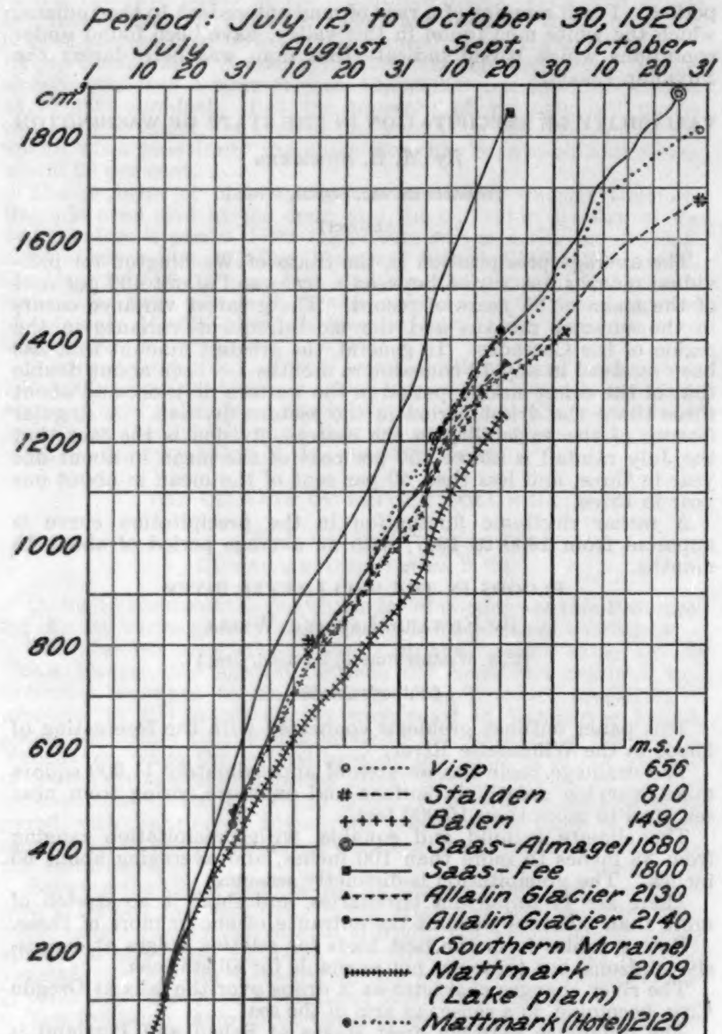

FIG. 1.—Evaporation measurements at various altitudes in the Visp region, by means of the Livingston porous cup atmometer

the various methods at the lake, evaporation being expressed in millimeters and temperatures in degrees centigrade. The results of other measurements carried out in the same region during the course of the work, are not summarized. Unfortunately there is nothing in the original text of the paper as printed to indicate the precise meaning of those column headings of Table 2 which read: Open station, sheltered station, lake east, and lake west. Presumably the first two refer to the topographic situation. The last two are, obviously, open to important differences of interpretation.

TABLE 1.—*Means of wind velocity and water temperature, totals of precipitation, total and mean daily evaporation, and maximum and minimum daily evaporation, for the Hopschensee, west of the summit of Simplon Pass, at 2,017 m. above sea level, for four periods, summer of 1921*

Month	Mean wind velocity (m./s.)	Mean water temperature [1] (° C.)	Total precipitation (mm.)	Evaporation from lake surface (mm.)			
				Total	Mean daily	Maximum daily	Minimum daily
July 25–Aug. 1 (7 days)[2]	2.9	18.0	0.4	29.0	4.1	4.7	3.1
Aug. 1–Sept. 1 (31 days)	3.1	13.3	146.3	73.5	2.4	7.7	0.2
Sept. 1–Oct. 1 (30 days)	2.7	12.2	63.9	54.5	1.8	3.7	0.35
Oct. 1–Oct. 23 (22 days)	2.45	9.2	0.0	41.3	1.9	3.4	0.9

TABLE 1a.—*The same data arranged in periods according to weather type*

I. Dry period, July 25–Aug. 10 (16 days)	2.9	17.3	3.1	70.7	4.4	7.7	1.7
II. Wet period, Aug. 10–Aug. 25 (15 days)	3.5	12.0	143.6	18.1	1.2	2.15	0.2
III. Damp period, Aug. 25–Sept. 23 (29 days)	2.8	12.2	63.9	53.5	1.8	3.75	0.35
IV. Dry period, Sept. 23–Oct. 23 (30 days)	2.4	9.9	0.0	56.0	1.9	3.4	0.9
Whole period from July 25–Oct. 23 (90 days)	2.8	12.3	210.6	198.3	2.2	7.7	0.2

[1] Means of morning and evening observations.
[2] Beginning and ending at 8 a. m. This arrangement applies to all the periods.

TABLE 2.—*Comparison of evaporation measurements, by means of porous cup atmometer and glass vessels, with those on the Hopschensee, summer, 1921*

[Evaporation in mm., temperatures in °C.]

Month	Atmometer						Glass vessels								Evaporation from the lake		Temperatures	
							Open station				Sheltered station							
	Open station		Lake east		Lake west		Large vessel		Small vessel		Large vessel		Small vessel					
	Total	Mean daily	Total	Mean daily	Total	Mean daily	Total	Mean daily	Total	Mean daily	Total	Mean daily	Total	Mean daily	Total	Mean daily	Air	Water
July 25–Aug. 1 (7 days)[1]	33.9	4.84	26.4	3.77	26.3	3.76	51.3	7.33	52.5	7.50	11.1	1.59	11.1	1.59	2.9	4.14	14.8	18.0
Aug. 1–Sept. 1 (31 days)	92.9	2.99	72.2	2.33	71.1	2.29	147.4	4.75	158.1	5.10	29.9	0.96	28.4	0.92	73.5	2.37	9.5	13.3
Sept. 1–Oct. 1(30 days)	83.4	2.78	67.6	2.25	69.8	2.33	125.9	4.20	133.3	4.45	24.1	0.80	23.6	0.79	54.5	1.82	9.1	12.2
Oct. 1–Oct. 23 (22 days)	73.4	3.34	55.7	2.53	55.7	2.53	90.0	4.09	94.8	4.31	21.3	0.97	22.3	1.02	41.3	1.88	7.7	9.2
Whole period from July 25 to Oct. 23 (90 days)	283.4	3.15	221.9	2.47	222.9	2.48	414.6	4.61	438.8	4.88	86.5	0.96	85.5	0.95	198.3	2.20	(Means) 9.3	12.3

[1] See footnote 2 of Table 1.

The general conclusions from the vaporation studies so far carried out in the lofty Simplon region are as follows: Evaporation from the high Alpine lakes is in general smaller than that from the lakes at the foot of the Alps. In the case of the high altitude lakes evaporation is somewhat aided by the reduced atmospheric pressure, but the increased effect from this cause is greatly outweighed by the effect of the lower temperatures. Local conditions may enter into the result as either a positive or a negative effect. There must be taken into consideration all the factors which determine the temperature of the water: The greater or less exposure of the lake and of its tributary region to insolation and wind; the character of the inflow into the lake; the area of the lake surface and the depth of the lake; the content of the snow cover; and the character of the adjacent land surface.—*B. M. V.*

METEOROLOGICAL DATA FOR MIDWAY ISLAND, NORTH PACIFIC OCEAN

A special meteorological station was established on Midway Island, N. lat. 28° 15′, W. long. 177° 22′, on May 1, 1917.

The instrumental equipment consists of a mercurial barometer, barograph, thermometers, anemometer, single register, and a rain gage, all standard instruments of the Weather Bureau pattern. A single observation is made at 6:30 p. m. daily, mean local time. This observation is cabled to Honolulu and thence to San Francisco, Calif.

Previous to the date above-mentioned observations of pressure and the direction and force of the wind were made at local noon and mailed to the Marine Division of the Weather Bureau in Washington, D. C. Through the cooperation of the chief of that division, Mr. F. G. Tingley, these earlier observations of pressure have been combined with the later ones, thus forming the series of 13 years of continuous observations presented in Table 1. Data for the other elements are confined to the period May, 1917, to December 31, 1924.—*A. J. H.*

TABLE 1.—*Meteorological data for Midway Island, North Pacific Ocean* [1]

MONTHLY MEAN PRESSURE (INCHES)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1912	29.87	30.04	30.18	30.24	30.14	30.08	30.03	30.01	30.00	30.00	30.07	30.07	30.061
1913	29.94	30.00	30.08	30.08	30.05	30.08	30.11	29.97	30.01	29.92	30.07	30.09	30.033
1914	30.15	29.99	30.19	30.17	30.22	30.13	30.09	30.06	29.97	30.03	30.09	30.10	30.099
1915	30.15	30.19	30.03	30.18	30.03	30.08	30.01	29.99	29.92	29.97	30.18	30.07	30.067
1916	29.81	29.85	29.99	30.13	30.11	30.05	30.07	30.07	29.96	30.00	30.06	29.89	29.999
1917	29.90	29.85	30.06	29.95	30.08	30.17	30.17	30.16	30.14	30.03	30.13	29.85	30.041
1918	29.94	30.05	30.08	30.18	30.11	30.07	30.06	30.05	29.97	30.04	30.14	30.14	30.069
1919	30.12	30.10	30.09	30.05	30.15	29.99	30.14	30.11	30.02	29.98	30.06	30.01	30.068
1920	29.94	29.94	30.15	30.12	29.94	30.01	30.11	30.09	30.07	29.99	30.15	29.97	30.040
1921	30.14	29.90	30.07	30.13	29.98	30.10	30.12	30.06	30.02	29.98	30.07	30.04	30.051
1922	30.03	30.03	30.03	30.22	30.11	30.03	30.05	30.04	30.02	30.07	30.05	29.89	30.048
1923	30.02	29.94	30.09	30.11	29.97	30.02	30.01	30.05	29.94	30.10	30.05	30.20	30.042
1924	30.00	30.07	30.05	30.11	30.08	30.02	30.19	30.11	30.04	30.08	30.06	29.90	30.059
Means	**30.001**	**29.996**	**30.084**	**30.128**	**30.075**	**30.064**	**30.089**	**30.059**	**30.006**	**30.015**	**30.091**	**30.017**	**30.052**

[1] Prior to May 1, 1917, observations were taken at local noon. Commencing on date named the hour of observation was changed to 6.30 p. m. A correction of −0.04 inch, for diurnal variation, has been applied to monthly means prior to that date, the correction having been determined from the barograph record. All readings corrected for gravity.

MONTHLY MEAN TEMPERATURE (° F)

[Based on daily means from (max.+min.)+2]

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1917	-----	-----	-----	-----	70.4	75.7	76.3	78.3	78.2	74.1	71.4	67.6	-----
1918	66.5	64.6	65.6	66.9	68.5	75.6	78.6	78.0	77.6	73.6	70.5	68.6	71.2
1919	65.5	66.2	66.4	68.1	72.0	72.0	75.6	78.2	75.8	72.8	67.3	65.2	70.4
1920	61.9	62.2	63.7	-----	-----	-----	79.2	78.3	79.0	75.2	72.6	68.2	-----
1921	66.3	64.6	65.4	68.2	70.5	76.0	77.2	78.6	79.0	75.6	72.6	67.7	71.8
1922	67.6	66.0	68.1	67.4	72.8	75.5	77.6	78.8	79.0	74.4	69.9	67.6	72.1
1923	65.7	64.4	64.8	68.2	71.1	76.4	78.0	78.4	77.4	74.4	69.7	66.0	71.2
1924	65.2	68.6	67.4	66.6	70.4	74.2	78.6	79.6	79.0	75.4	70.2	65.3	71.7
Means	**65.5**	**65.2**	**65.9**	**67.6**	**70.8**	**75.1**	**77.6**	**78.5**	**78.1**	**74.4**	**70.5**	**67.0**	**71.4**

MONTHLY PRECIPITATION (INCHES)

1917	-----	-----	-----	-----	2.81	3.30	2.66	1.26	1.32	7.46	0.54	5.60	-----
1918	8.19	3.63	3.28	0.46	0.97	0.35	2.84	5.64	7.43	10.01	0.70	1.54	45.04
1919	0.76	2.30	5.42	3.40	0.53	3.87	1.57	0.04	5.44	2.83	0.70	1.52	28.38
1920	1.50	4.20	6.81	6.07	3.87	6.53	0.91	2.94	4.79	12.41	2.56	5.36	57.95
1921	1.27	6.05	2.84	5.11	6.43	0.54	8.22	2.76	3.65	5.50	1.61	2.65	46.63
1922	2.30	4.61	3.71	0.36	2.46	2.33	4.56	4.70	5.25	3.69	5.12	6.03	45.12
1923	1.12	3.99	3.52	0.96	12.59	2.86	4.33	4.14	7.41	0.85	1.72	0.46	43.95
1924	8.63	1.31	2.58	1.52	0.86	5.06	1.17	5.10	3.92	3.47	0.43	6.28	40.33
Means	**3.40**	**3.73**	**4.02**	**2.55**	**3.82**	**3.10**	**3.28**	**3.32**	**4.90**	**5.78**	**1.67**	**3.68**	**43.25**

WIND DIRECTIONS—NUMBER OF OBSERVATIONS (MAY 1917—DECEMBER 1924, INCLUSIVE)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
N	17	10	14	23	15	12	3	6	7	19	19	13	158
NE	38	29	49	90	84	72	111	113	83	114	75	45	903
E	24	14	35	42	26	30	67	85	43	37	31	19	453
SE	19	21	37	22	38	56	35	33	68	17	25	22	393
S	21	13	11	9	19	21	15	8	7	7	11	17	159
SW	43	48	30	5	14	18	8	0	12	14	24	44	260
W	20	21	12	8	19	13	6	2	10	18	19	35	183
NW	34	42	29	10	26	15	3	1	6	19	33	52	270
Calm	1	0	0	1	7	3	0	0	4	3	3	1	23
Total observations	**217**	**198**	**217**	**210**	**248**	**240**	**248**	**248**	**240**	**248**	**240**	**248**	**2,802**

MEAN MONTHLY WIND VELOCITY (m. p. h.)[2]

1917	-----	-----	-----	-----	11.9	22.3	25.5	15.1	13.6	27.0	15.7	20.2	18.9
1918	16.5	20.0	23.2	19.5	15.3	11.3	13.4	16.4	15.8	18.3	21.9	16.7	17.4
1919	11.0	12.6	14.7	8.9	9.4	8.1	13.7	8.5	13.5	13.3	12.6	16.8	11.9
1920	16.5	18.0	12.1	11.7	12.3	9.3	11.7	10.5	10.8	10.1	13.2	17.5	12.8
1921	15.9	18.9	14.8	16.9	10.8	8.8	16.6	12.1	15.4	17.5	13.0	17.8	14.9
1922	15.5	20.0	16.7	15.4	13.4	12.2	13.1	11.8	9.0	14.7	17.5	19.0	14.9
1923	17.0	19.0	14.6	11.3	10.4	8.9	8.2	9.2	12.4	12.6	15.9	13.0	12.7
1924	14.0	14.1	12.8	14.5	10.5	8.8	12.8	11.3	6.8	15.3	13.5	18.5	12.7
Means	**15.2**	**17.5**	**15.6**	**14.0**	**11.8**	**11.2**	**14.4**	**11.9**	**12.2**	**16.1**	**15.4**	**17.4**	**14.4**

[2] Based on one observation daily.

THE DRY SEASON OF 1925 IN THE PANAMA CANAL ZONE

(Extracts from report by H. Z. Kirkpatrick, chief hydrographer, dated Balboa Heights, June 11, 1925)

Meteorologically, the dry season began about January 7 and ended about April 23, but it was preceded and followed by a transition period of several weeks' duration. Dry season symptoms began to be noticeable by December 6 and continued rainy season conditions began about May 17.

The actual duration of dry conditions was slightly below the average; but from a water-supply standpoint, this season was the fourth driest in the last 14 years.

Comparative figures on the basis of length of time, amount of rainfall, and Gatun Lake net inflow, on the dry season for the past 14 years are given in the following Table 1:

TABLE 1.—*Comparison of dry seasons since the formation of Gatun Lake, 1912 to 1925, inclusive*

RAINFALL—INCHES

Stations	Dec. 1, 1911, to May 7, 1912, inclusive, 159 days.	Jan. 2 to Apr. 23, 1913, inclusive, 112 days	Dec. 23, 1913, to Apr. 24, 1914, inclusive, 123 days	Jan. 7 to Apr. 19, 1915, inclusive, 103 days	Dec. 26, 1915, to Apr. 10, 1916, inclusive, 107 days	Dec. 18, 1916, to Apr. 26, 1917, inclusive, 130 days	Dec. 20, 1917, to Apr. 19, 1918, inclusive, 121 days	Nov. 27, 1918, to Apr. 12, 1919, inclusive, 137 days	Dec. 16, 1919, to May 13, 1920, inclusive, 150 days	Dec. 8, 1920, to May 11, 1921, inclusive, 155 days	Jan. 7 to May 4, 1922, inclusive, 118 days	Jan. 4 to May 4, 1923, inclusive, 121 days	Dec. 19, 1923, to Apr. 19, 1924, inclusive, 123 days	Jan. 7 to Apr. 23, 1925, inclusive, 107 days
	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925
Porto Bello	5.74	9.67	7.37						10.18	23.87	13.92	15.68	10.59	9.57
Colon	6.37	8.15	5.55	21.98	7.68	4.14	7.90	5.33	5.26	14.05	5.39	3.88	4.94	5.11
Gatun	10.30	10.85	5.46	25.14	7.09	3.62	10.20	4.92	3.37	13.16	7.41	4.77	6.23	7.87
Monte Lirio	9.29	6.63	6.50	16.13	6.76	3.43	9.68	7.14	2.41	14.96	4.75	4.03	7.33	4.47
Gamboa	3.03	3.45	2.23	6.92	5.08	1.31	4.09	2.36	2.52	7.69	3.56	1.13	3.35	2.54
Alhajuela	1.02	1.22	.43	7.54	2.41	.67	2.24	1.52	1.78	5.81	1.22	1.33	2.17	1.83
Vigia	1.60	1.72	1.15	6.14	2.04	1.14	3.30	1.91	1.51	4.50	1.22	2.05	2.63	1.28
Culebra	3.85	2.93	.91	6.42	3.98	1.05	3.25	1.06	2.79	2.94	2.64	.66	2.44	1.31
Empire	3.20	2.66	.88	6.93	3.61	.75	2.57	1.78	3.02	4.38	1.69	.60	1.80	1.60
Pedro Miguel	6.29	1.14	3.17	3.24	3.04	2.92	7.27	2.00	6.15	4.60	5.64	.47	1.66	3.46
Balboa Heights	4.76	1.28	2.32	4.56	3.97	3.63	5.43	.93	4.46	10.64	3.69	1.96	.38	1.36

CORRESPONDING NET YIELD OF GATUN LAKE WATERSHED (C. F. S.)

	[1] 10	1,267	782	2,794	1,336	519	1,329	998	9	873	1,347	658	736	525

[1] No accurate data for this dry season. Revised estimate using Chagres River discharge and comparing with other dry seasons.

Chagres River.—The Chagres River discharge at Alhajuela was 18 per cent below the 24-year, 4-month (January to April, inclusive) dry season average, or 1,028 c. f. s. against a mean of 1,251 c. f. s. The minimum discharge of the Chagres for the four months was 467 c. f. s. on April 24; the maximum discharge for the same period was 13,300 c. f. s. on January 3.

Gatun Lake.—Gatun Lake continued to fall, but to a lesser extent, during the transition period from dry to rainy conditions and the lowest point, 82.57 feet was reached on May 17. This represents a loss in storage of 20.67 billion cubic feet as compared with 14.60 billion cubic feet for last year and 24.42 billion cubic feet in 1920. The above figures are total storage losses from maximum lake height to minimum height.

Gatun hydroelectric carried full Isthmian power load during the dry period and used 15.86 billion cubic feet from January to April, inclusive, while 9.03 billion cubic feet were the requirements for lockage water during the same period; i. e., ratio of 1.756 to 1.

A total of 1,598 lockages $\left(\frac{\text{Gatun}+\text{Pedro Miguel}}{2}\right)$ were made during the four-month period, compared with 1,825 for last year and 1,572 for the same period in 1923. The requirements per through lockage per 24 hours were 65 c. f. s. for 1925, 72 c. f. s. for 1924, and 82 c. f. s. for 1923.

The saving at the locks during the four months, January to April, inclusive, amounted to approximately 0.45 foot on Gatun Lake.

Table 2 shows the net inflow into Gatun Lake for the dry-season months since the formation of the lake; Table 3 gives the hydrology of Gatun Lake for the four-month period, January 1 to April 30, inclusive, 1925.

TABLE 2.—*Net yield in c. f. s., dry seasons of record, Gatun Lake* [1]

	1912 [2]	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	Average for month
December [3]	2,690	5,335	4,307	7,010	7,673	4,986	9,218	2,158	4,939	3,698	7,649	7,842	4,232	7,742	5,677
January	400	2,583	1,739	2,570	1,863	1,111	3,023	1,541	769	1,216	8,641	2,363	1,050	2,565	2,245
February	271	1,298	744	4,207	1,320	139	431	73	−287	951	1,482	698	1,041	601	926
March	−392	678	167	823	698	−182	36	−50	−385	−121	190	−84	98	−278	85
April	−363	567	308	5,400	1,076	447	1,119	3,250	−706	244	210	−185	2,303	652	1,023
May	2,771	4,992	3,219	6,111	4,063	4,635	7,964	4,352	583	2,109	4,605	2,825	4,754	1,792	3,912

[1] Net yield is the total yield minus evaporation on Gatun Lake.
[2] Estimated.
[3] Decembers are of previous years; i. e., December, 1911, is in 1912 dry season.

TABLE 3.—*Hydrology of Gatun Lake watershed. Dry season 1925, January to April, inclusive*

[Drainage area, 1,320 square miles]

(Gatun Lockages, 1,542; Pedro Miguel Lockages, 1,655)

Gatun Lake	Elevation	Date
Monthly mean	85.28	
Maximum	87.10	Jan. 1
Minimum	82.97	Apr. 25

	Quantities	
	Million cubic feet	Second-feet
Gatun spillway, waste	1,788.2	172.5
Gatun spillway, leakage	37.2	3.6
Gatun Locks, lockages and tests	4,868.1	469.5
Gatun Locks, leakage	95.0	9.2
Gatun hydroelectric plant	15,857.6	1,529.5
*Pedro Miguel Locks, lockages and tests	4,163.2	401.5
*Pedro Miguel Locks, leakage	54.1	5.2
*Maintaining Miraflores Lake through Pedro Miguel Locks	0.0	0.0
Pumping at Gamboa	131.2	12.7
Brazos Brook Reservoir	211.6	20.4
*Pumping at Gaillard Cut	0 0	0.0
a. Total outflow	27,206.2	2,624.1
b. Storage (+increase, −decrease)	−17,936.5	−1,730.0
c. Net yield (a±b)	9,269.7	894.1
d. Evaporation (21.987")	8,359.5	806.3
e. Total yield (c+d)	17,629.2	1,700.4
f. Rainfall on lake (9.62")	3,634.3	350.5
g. Yield from land area (e−f)	13,994.9	1,349.9
*Transferred to Miraflores Lake	4,217.3	406.7

	Mean area, square miles	Rainfall, inches	Run-off, inches	Percentage, run-off
Lake surface	163.9	9.62	9.62	100
Land area	1,156.1	8.71	5.23	60
Total watershed	1,320	8.82	5.73	65

RIVER REGULATION

[Regulation of Rivers without Embankments, as Applied in the Training Works, at the Headwaters of the Rangoon River, Burma (locally known as the Myitmaka Training Works). By F. A. Leete, assisted by G. C. Cheyne]

In Nature, June 6, 1925, Mr. Brysson Cunningham presented a very interesting review of the above publication, and below are given the essential features thereof.

The basic proposition advanced is that a river may be left to effect its own training without the use of embankments of any kind, including all artificial aids to bank formation, with the exception of sticks of bamboo. The scene of operations was among the headwaters of the Rangoon River in Burma, used mainly for the transportation of teak logs. The streams are fed from torrents from the hills with an extreme altitude of about 2,500 feet, the annual rainfall varying from 60 to 120 inches. During the monsoon season high floods occur at frequent intervals, carrying immense quantities of sand and clay in suspension. At the foot of the hills the flood waters spread out over the plain submerging the paddy fields and producing a series of swamps, with the result that the teak logs were left stranded with much resulting loss.

Formerly embankments, at first high and then low, were constructed at great cost, but in 1917 came the inspiration that no embankments at all were necessary. It had been observed that soil deposits occurred around stranded logs and other debris; therefore a trial fence of bamboo stakes was made along the desired line of embankment. The method was simple. After the proposed line of channel had been pegged out, following the natural depressions as a rule, all growth was removed to a width of 150 feet on each side of the line. One hundred feet on each side of the line, fences were made by driving into the ground pointed bamboos, 5 or 6 feet long, and about 9 inches apart, with the tops dressed to a steady slope, and about 3 feet above ground level. The stakes were lashed to a horizontal rail about 6 inches from their tops, with coir (coconut fiber) rope.

The outcome fully justified the original conception. The fences caught much small rubbish and formed a barrier checking the flow of the water. This check caused a deposit of the heavier sand particles on the streamside of the fence, while the finer particles were carried beyond it. The stakes (fence) became imbedded in the deposit, which gradually accreted to heights ranging up to 9 or 10 feet or even more. Thus natural embankments were formed and the river channel completely defined. When the first row of stakes is buried, a second row may be driven, but this is not often necessary. Finally the river bank becomes so high that the channel is large enough to carry the whole normal flood water. The forming banks serve as well to raise the level of the surrounding country, thus reclaiming considerable tracts for cultivation. Bad bends in the river are eliminated by short cuts.

The method is not one of universal application, but it is suitable in the case of streams originating as hillside torrents and heavily charged with detritus and sandy silt, chiefly in their upper reaches. Considerable variation in water level and frequent overtopping of banks in the early stages are features of the course of channel formation, and when these are lacking, the method can not be utilized, or at any rate, not so effectively.—*H. C. F.*

A CONCRETE RAIN-GAUGE SUPPORT

[Extracts from a memorandum by S. D. Flora, Weather Bureau, Topeka, Kans.]

An excellent form of support for a rain gage that will last indefinitely consists of a cement block 12 inches square into which four gas pipes were inserted before the cement had set, so that the can of the rain gauge is held firmly by them, but with enough space so that it can be lifted out. The gas pipes project 21 inches above the cement.

The block need not, of course, be exactly of the size specified above. It is a good idea in practice to bury part of it so that the bottom of the gauge is held about 3 inches above the ground. The cost of this support should not exceed $3.

METEOROLOGICAL SUMMARY FOR SOUTHERN SOUTH AMERICA, AUGUST, 1925

[Reported by Señor J. B. Navarrete, El Salto Observatory, Santiago, Chile. Translation by B. M. V.]

The month of August was relatively dry in the central zone of Chile and somewhat rainy in the south during the first 15 days. From the 2d to the 6th important atmospheric depressions crossed the southern region, causing general rains over nearly the whole of it. The maximum precipitation in 24 hours occurred on the 5th at Valdivia. On the 4th there were local rains on the high plateau of Bolivia and in the interior of Tacna Province.

On the 7th and 8th an anticyclonic center was established in the interior of the continent at latitude 40°, with a fall of temperature and fine weather.

From the 9th to the 12th there was a renewed development of atmospheric disturbances in the southern region; general rains occurred, and on the 11th heavy snowfall occurred in Magellanes Province.

Between the 13th and 15th a large anticyclone formed over the southcentral part of the continent, with the maximum pressure 774 mm. (1,032 mb.) at Cipolleti (Argentina). Fine, cold weather was the rule, with freezing temperatures.

On the 16th a depression appeared in the northwest, along the Pacific coast off Coquimbo; on the 17th it influenced the central zone of Chile, giving local rains; on the 18th took place the phenomenon of the compression of the cyclone by strong converging winds of excessive velocity originating in the southern anticyclone (according to the laws of Guilbert). On the 18th local rains fell in northern Argentina, in Buenos Aires Province, and in parts of Uruguay.

During the 19th–20th an anticyclonic régime dominated the continent.

On the 21st a large depression influenced the southern area, causing a heavy rain and wind storm, the bad weather and rains lasting in the southern part of this area until the 23d. From the 24th to the 30th the anticyclonic régime persisted over the greater part of the continent.

In Bolivia, during the 25th and 26th, violent electrical storms broke over La Paz and Sucre, with rain and hail.

On the 30th and 31st a severe hot wave invaded the central zone of Chile; at Los Andes the thermometer registered 30° C. in the shade.

BIBLIOGRAPHY

C. FITZHUGH TALMAN, in Charge of Library

RECENT ADDITIONS

The following have been selected from among the titles of books recently received as representing those most likely to be useful to Weather Bureau officials in their meteorological work and studies.

Almeida Lima, João Maria de, comp.
A chuva e outros hidro-meteoros em Portugal. Lisboa. 1916. 72 p. plates. 36½ cm.
O clima de Portugal continental. Lisboa. 1922. 81 p. 33½ cm.

Denmark. Danske meteorologiske institut.
Isforholdene i de Arktiske have samt havets overfladetemperatur i det nordlige Atlanterhav og Davis-Stræde. (State of the ice in the Arctic seas and the surface temperature of the sea in the northern Atlantic-ocean and in Davis-Strait.) 1923–1924. København. 1924–25. 31½ cm. (Sært.; Naut. met. aarb., 1923–24.)

Dobie, J. Frank.
Weather wisdom of the Texas-Mexican border. 13 p. 23½ cm. (Repr.: Pub. Texas folk-lore soc., no. 2, 1923.)

Enström, Axel F.
On periodicities in climatic and economic phenomena and their covariation. Stockholm. n. d. 56 p. illus. 24 cm. (Ingeniörsvetenskapsakademiens handlingar nr. 31, 1924.)

Froc, L[ouis.]
Typhoon of August 5th to 23rd, 1924. Shanghai. 1925. 12 p. plate. 22½ cm.

Greenburg, Leonard.
Studies on the industrial dust problem. no. 3. Comparative field studies of the Palmer apparatus, the konimeter, and the impinger methods for sampling aerial dust. [Washington.] 1925. p. 1591–1603. 23½ cm. (Public health reports. v. 40, no. 31, July 31, 1925.)

Hamed, Mahmoud.
Climate of Alexandria. Cairo. 1925. 62 p. plates. 28 cm. (Min. pub. works, Egypt. Phys. dept. paper no. 19.)

Hunter, H. C.
Tornadoes of the United States, 1916–1923. Washington. 1925. p. 198–204. figs. 30½ cm. (Repr.: Mo. wea. rev., v. 53, May, 1925.)

Lisboa. Observatório central meteorológico.
Comunicados meteorológicos. Instruções para a redacção em cifra, dos telegramas e radiotelegramas meteorológicos internacionais. Lisboa. 1923. 14 p. 22½ cm.

Das Luftschiff als Forschungsmittel in der Arktis. Eine Denkschrift mit vier Anlagen. [Berlin.] n. d. 62 p. plates (fold.) 23½ cm. (Herausgegeben von der Internationalen Studiengesellschaft zur Erforschung der Arktis mit dem Luftschiff, 7. Oktober 1924.)

McConnell, W. J., & *others*.
Basal metabolism before and after exposure to high temperatures and various humidities. Washington. 1925. 14 p. figs. 23½ cm. (Repr.: Pub. health rep., no. 977, Dec. 5, 1924.)

Robertson, C. L.
Review of the abnormal rainfall season of 1924–25. Salisbury. n. d. 11 p. plates. 24½ cm. (Repr.: Rhodesia agric. journ., Bull. no. 542. June, 1925.)

Shantz, Homer Le Roy & Marbut, C. F.
Vegetation and soils of Africa . . . with a section on the land classification of Africa . . . and a note on a rainfall map of Africa, by J. B. Kincer. New York. 1923. x, 263 p. illus. (maps.) plates. 21 cm. (Amer. geogr. soc. Research series no. 13.)

Szymkiewicz, Dezydery.
Études climatologiques. no. 6. Warszawa. n. d. p. 115–137. illus. plates (part fold.) 24½ cm. (Extr.: Acta soc. bot. Poloniae. v. 3, nr. 1, 1925.)

Talman, Charles F.
Work of the weather men. Film slide manual. Buffalo. n. d. 14 p. 22 cm. [Prepared to accompany a set of film-slides for use in projector lantern.]

Viger, A.
L'Atmosphère. [Paris. c1925.] 192 p. illus. plates. 18½ cm.

Ward, Robert DeC.
Importance of field-work in the study of climates. p. 64–77. 24½ cm. (Repr.: Proc. Amer. phil. soc., v. 44, no. 1, 1925.)

Werenskiold, Werner.
Fysisk geografi i geofysikk, meteorologi, oceanografi. Oslo. 1925. vii, 347 p. illus. 24 cm.

Wolfer, A.
Observed sunspot relative numbers, 1749–1924. p. 83–86. 24 cm. (Terr. mag. & atmos. elec., June, 1925.)

RECENT PAPERS BEARING ON METEOROLOGY

The following titles have been selected from the contents of the periodicals and serials recently received in the library of the Weather Bureau. The titles selected are of papers and other communications bearing on meteorology and cognate branches of science. This is not a complete index of all the journals from which it has been compiled. It shows only the articles that appear to the compiler likely to be of particular interest in connection with the work of the Weather Bureau.

Akademie der Wissenschaften. Sitzungsberichte. Wien. Abt. IIa. Band 133. 1924.

Schlenck, Walter. Experimentelle Untersuchungen über die Charakteristik des Stromes in schwach ionisierten Gasen. p. 29–33. (Heft 1 u. 2.)

Schweidler, Egon. Über die Charakteristik des Stromes in schwach ionisierten Gasen. p. 23–27. (Heft 1 u. 2.)

Exner, Felix M. Über die Auslösung von Kälte- und Wärmeeinbrüchen in der Atmosphäre. p. 101–115. (Heft 3 u. 4.)

Wagner, Arthur. Eine Bemerkenswerte 16jährige Klimaschwankung mit einem Anhang: Mögliche Perioden verschiedener Wellenlänge. p. 169–224. (Heft 5 u. 6.)

Annalen der Hydrographie und maritimen Meteorologie. Berlin. 53. Jahrgang. Juni 1925.
Castens, Gerhard. Über Tropenklimatologie, Tropenhygiene und den Lettow-Feldzug. p. 177–187.
Peterson, P. Die Eisverhältnisse an den deutschen Küsten, in Memel und der freien Stadt Danzig während des Winters 1924/25. p. 193–197.
Stöbe, W. Aufgabe und Ziel der Flugwetterwarte. p. 199–202.
Wiese, W. Einige Beziehungen zwischen der Zeit des Erscheinens des Eises im Finnischen Meerbusen und hydrographischen und meteorologischen Phänomenen. p. 191–193.

Annalen der Physik. Leipzig. Band 77, no. 9. 1925.
Kähler, K., & Dorno, C. Über die Elektrisierung von Wasser, Schnee und anderen festen Substanzen durch feinste Zerstäubung. p. 71–80.

Discovery. London. v. 6. September, 1925.
Howarth, O. J. R. The elementary geography of the air. p. 323–324.

Ecology. Brooklyn. v. 6. July, 1925.
Belyea, Harold Cahill. Wind and exposure as limiting factors in the establishment of forest plantations. p. 238–240.

France. Académie des sciences. Comptes rendus. Paris. t. 181. 1925.
Gabriel, Jules. Sur un cycle luni-solaire de 744 années, divisé en 2 périodes de 372 années et 4 semipériodes de 186 années. p. 22–24. (6 juil.)
Gabriel, Jules. Sur l'application à la météorologie du cycle astronomique de 744 années. p. 187–189. (27 juil.)
Faucher, D., & Rougetet, E. Contribution à l'étude du mistral. L'accélération. p. 323–326. (31 août.)

Hemel en dampkring. Den Haag. 23 jaargang. Augustus, 1925.
Hartman, Ch. M. A. De lente van 1925. p. 205–206.
Monné, A. J., & Nell, Chr. A. C. Nieuwere onderzoekingen over klimaatverschillen in de hoogere luchtlagen boven Soesterberg en Scheveningen. p. 206–215.

International institute of agriculture. International review of the science and practice of agriculture. Rome. New series. v. 3. April–June, 1925.
Butler, E. J. Meteorological conditions and plant diseases. p. 369–384. [With bibliography.]

Matériaux pour l'étude des calamités. Genève. Année 2. Avril-juin 1925.
Allix, André. Les catastrophes de la neige. p. 37–57.
Pouichet, E. P. Les crues de l'embouchure de la Neva. p. 3–36.

Meteorologische Zeitschrift. Braunschweig. Band 42. Juli 1925.
Arendt, Th. Vom Brockengespenst. p. 280–282.
Aufsess, Otto Freiherr von u. zu. Kosmische Einflüsse auf die Luftdruckverteilung über Mitteleuropa. p. 277–280.

Meteorologische Zeitschrift—Continued.
Fagermo, Martin. Eine seltene Haloerscheinung. p. 272–275.
Ficker, H. v. Die Höhe der Schneegrenze in den Pamirgebieten p. 276–277.
Hellmann, G. Über die Häufigkeit des Vorkommens von Tau und Reif. p. 257–260.
Peppler, W. Die Fallrichtung der Registrierballone in den Zyklonen und Antizyklonen. p. 282.
Röstad, A. Über die Wirkung des Nipherschen Schutztrichters. p. 266–272.
Schostakowitsch, W. B. Die Eisdicke der Gewässer Ostsibiriens. p. 282–285.
Wegener, Alfred. Die äusser Hörbarkeitszone und ihre periodische Verlagerung im Jahreslauf. p. 261–266.

Nature. London. v. 116. Sept. 12, 1925.
Reynolds, William C. The distribution of the two electrical zones in the atmosphere. p. 394–395.

Nature. Paris. 53 année. 29 août 1925.
Legendre, R. L'équilibre acide carbonique-carbonates des trois phases air-eau-terre du globe. p. 138–142.

Reale accademia dei Lincei. Atti. Roma. Rendiconti. v. (6)1, fasc. 12. 1925.
Pacini, D. Osservazioni sulla corrente verticale di conduzione atmosfera-terra. p. 713–716.

Revue de geographie alpine. Grenoble. t. 13. 1925. fascicule 2.
Allix, André. Les avalanches. p. 359–423.

Royal astronomical society of Canada. Journal. Toronto. v. 19. June-July, 1925.
Christie, William H. A remarkable solar halo complex. p. 115–117.

Science. New York. v. 62. July 24, 1925.
Jordan, David Starr. The art of pluviculture. p. 81–82.
Pessin, L. J. A simplified rainproof valve for porous porcelain atmometers. p. 85–86.

Scientific monthly. New York. v. 21. September, 1925.
Humphreys, W. J. The thunderstorm. p. 253–257.

Scottish geographical magazine. Edinburgh. v. 41. July 15, 1925.
Semple, Ellen Churchill. Climatic influence in some ancient Mediterranean religions. p. 214–221.

Società meteorologica italiana. Bollettino bimensuale. Torino. v. 44. Aprile-giugno 1925.
Alippi, Tito. Nubi iridate. p. 33–38.
Crestani, Giuseppe. Un caso interessante di vetrone. p. 44–46.
Pagnini, Pietro. L'arco porpora e l'altezza ottica dell' atmosfera. p. 38–44.

Terrestrial magnetism and atmospheric electricity. Baltimore. v. 30. June, 1925.
Wolfer, A. Observed sunspot relative numbers, 1749–1924. p. 83–86.

SOLAR OBSERVATIONS

SOLAR AND SKY RADIATION MEASUREMENTS DURING AUGUST, 1925

By HERBERT H. KIMBALL, Solar Radiation Investigations

For a description of instruments and exposures and an account of the method of obtaining and reducing the measurements, the reader is referred to the REVIEW for January, 1924, **52** : 42 and January, 1925, **53** : 29.

From Table 1 it is seen that solar radiation measurements averaged slightly below normal values for August at Lincoln, Nebr., and close to normal at Washington, D. C., and Madison, Wis.

Table 2 shows that the total solar and sky radiation received on a horizontal surface averaged above the August normal at Washington and Madison, and slightly below normal at Lincoln.

At Washington skylight polarization measurements made on 5 days give a mean of 51 per cent, with a maximum of 56 per cent on the 22d. At Madison, measurements made on 5 days give a mean of 55 per cent with a maximum of 65 per cent on the 21st. These are slightly below the normal values for August at both Washington and Madison.

TABLE 1.—*Solar radiation intensities during August, 1925*

[Gram-calories per minute per square centimeter of normal surface]

Washington, D. C.

Date	Sun's zenith distance										
	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass									Local mean solar time
		A. M.					P. M.				
	e.	5.0	4.0	3.0	2.0	[1] 1.0	2.0	3.0	4.0	5.0	e.
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm.*
Aug. 1	11.81		0.78	0.88	1.04						9.47
10	16.79					1.20					14.10
14	19.23				0.91						17.37
15	15.11		0.56	0.72	0.93	1.17					14.10
17	15.65		0.62	0.77	0.97						12.24
19	14.10					1.05					15.65
21	14.60						1.08	0.95	0.86	0.65	15.11
22	8.18	0.76	0.87	1.04	1.24	1.43					7.29
24	11.38			0.75	0.92						10.97
25	12.68			0.74	0.85	1.02					12.24
26	13.61			0.64	0.82	1.21					14.10
Means		(0.76)	0.71	0.79	0.96	1.18	(1.08)	(0.95)	(0.86)	(0.65)	
Departures		+0.10	+0.03	+0.02	+0.03	−0.04	+0.07	+0.07	+0.12	±0.00	

TABLE 1.—*Solar radiation intensities during August, 1925*—Con.

Madison, Wis.

Date	Sun's zenith distance										
	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass									Local mean solar time
		A. M.					P. M.				
	e.	5.0	4.0	3.0	2.0	[1] 1.0	2.0	3.0	4.0	5.0	e.
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm.*
Aug. 4	11.81					1.00					12.24
10	11.38				1.07						12.24
21	8.18			1.13	1.28	1.44	1.22				8.48
26	11.81					1.30					11.38
28	10.59					1.25					10.97
31	12.24			1.06	1.25		1.18				9.47
Means				(1.10)	1.20	1.25	(1.20)				
Departures				+0.16	−0.10	−0.06	+0.14				

Lincoln, Nebr.

Date	8 a.m.	5.0	4.0	3.0	2.0	[1] 1.0	2.0	3.0	4.0	5.0	Noon
Aug. 1	9.83	0.73	0.83	1.00	1.19	1.39					8.18
4	11.81		0.70	0.84	0.97						11.38
8	15.65		0.62	0.82	1.02						17.37
14	12.24							0.80	0.60	0.50	14.10
15	13.61			0.95	1.11	1.30	1.02	0.89	0.76	0.68	15.11
17	14.10					1.29	1.10	0.90	0.76	0.65	18.59
18	15.65	0.69	0.81	0.93	1.08	1.30	0.98				17.37
22	9.83				1.08	1.34	1.08	0.88	0.72	0.59	12.68
23	12.24	0.68	0.79	0.92							16.20
24	10.97		0.76	0.93	1.10	1.32	0.98	0.78	0.63	0.52	14.60
25	15.11	0.41	0.47	0.63	0.92	1.18	0.85	0.58			16.20
26	12.24	0.49	0.60	0.73	0.92	1.19					13.13
27	15.11	0.40	0.47	0.61	0.83						13.13
28	11.38	0.45	0.53	0.69	0.88	1.22					14.10
31	11.38		0.84	0.98	1.17	1.38					15.65
Means		0.55	0.67	0.84	1.02	1.29	1.00	0.80	0.69	0.59	
Departures		−0.09	−0.10	−0.05	−0.05	±0.00	−0.07	−0.08	−0.06	−0.11	

[1] Extrapolated.

TABLE 2.—*Solar and sky radiation received on a horizontal surface*

[Gram-calories per square centimeter of horizontal surface]

Week beginning—	Average daily radiation					Average daily departure from normal		
	Washington	Madison	Lincoln	Chicago	New York	Washington	Madison	Lincoln
	cal.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
July 30	382	518	522	360	359	−77	+48	−12
Aug. 6	404	414	387	358	397	−46	−41	−129
13	530	392	511	338	370	+95	−49	+17
20	509	511	550	424	373	+90	+86	+68
27	511	430	491	480	433	+106	+27	+29
Excess since first of year on Sept. 2, 1925						+2,135	+2,233	+707

WEATHER OF NORTH AMERICA AND ADJACENT OCEANS

NORTH ATLANTIC OCEAN

By F. A. YOUNG

The following table shows the average sea-level pressure and departure for the month, as well as the highest and lowest barometric readings at a number of land stations on the coast and islands of the North Atlantic. The readings are for 8 a. m., seventy-fifth meridian time, and the departures are only approximate, as the normals are taken from the Pilot Chart and are based on Greenwich mean noon observations, which correspond to those taken at 7 a. m., seventy-fifth meridian time.

Stations	Average pressure	Departure	Highest	Date	Lowest	Date
	Inches	*Inches*	*Inches*		*Inches*	
St. Johns, Newfoundland	29.92	−0.07	30.28	Aug. 31	29.58	Aug. 21
Nantucket	30.05	+0.05	30.42	Aug. 24	29.74	Aug. 1
Hatteras	30.05	+0.01	30.32	Aug. 30	29.78	Aug. 21
Key West	30.00	+0.02	30.08	Aug. 2, 14.	29.90	Aug. 16
New Orleans	30.05	+0.08	30.16	Aug. 2	29.96	Aug. 8, 9.
Swan Island	29.88	−0.03	29.96	Aug. 1	29.84	Aug. 6[1]
Turks Island	30.03	+0.03	30.12	Aug. 1	29.96	Aug. 19
Bermuda	30.13	+0.04	30.26	Aug. 4, 25.	29.94	Aug. 28
Horta, Azores	30.26	+0.06	30.42	Aug. 1	29.98	Aug. 6
Lerwick, Shetland Islands	29.83	+0.03	30.31	Aug. 14	29.52	Aug. 29
Valencia, Ireland	29.97	+0.05	30.44	Aug. 30	29.44	Aug. 21
London	29.99	+0.01	30.39	Aug. 30	29.56	Aug. 22

[1] And other dates.

Comparatively small departures were the rule. It can be stated also that the change in pressure from day to day was less than usual.

The number of winds of gale force was somewhat above the normal over the northern steamer lanes east of the forty-fifth meridian, where they were reported on from two to four days, while moderate weather prevailed off the American coast.

The number of days with fog was somewhat below normal over the Grand Banks, and considerably above in the vicinity of Nantucket and over the steamer lanes east of the thirty-fifth meridian.

The month began with depressions near Newfoundland and over the North Sea, and vessels in the middle section of the steamer lanes encountered moderate southerly gales. The western LOW moved rapidly eastward and on the 2d was central near 55° N., 30° W., while the eastern depression remained nearly stationary, with moderate weather over the entire ocean.

On the 4th northerly gales prevailed over the northern steamer lanes between the twentieth and fortieth meridians, as shown by storm report in table from the British S. S. *Manchester Merchant*.

On the 6th there was a LOW central near 55° N., 35° W., and moderate to strong northerly to northwesterly gales were reported on that date and also on the 7th from a limited area between the forty-fifth and sixtieth parallels and the thirty-fifth and fortieth meridians. This LOW drifted slowly eastward and on the 10th was off the north coast of Scotland, where it remained nearly stationary until the 12th. During this period moderate weather prevailed on every day except the 11th, when southwesterly gales occurred between the forty-fifth and fiftieth parallels and the twenty-fifth and thirty-fifth meridians. This depression was comparatively deep, with a minimum barometer reading of 29.28 inches on the 9th near 58° N., 13° W.

No gale reports have been received covering the period from the 13th to 18th, although at times the pressure gradients were fairly steep.

At the time of observation on the 19th the weather was still moderate, but later in the day the barometer began to fall over both the eastern and western sections of the ocean, and from the 20th to 22d there ensued the severest weather of the month. The conditions for this period are shown by Charts VIII to X.

On the 20th, as shown by Chart VIII, there was a fairly well defined depression near Father Point, Quebec, and also a secondary LOW central some distance northeast of Bermuda. At the time of observation on both the 19th and 20th winds of force 4 to 6 were recorded in the vicinity of Bermuda, but early in the morning of the 20th the American S. S. *Antinous*, about 150 miles to the northeast of the islands, ran into a gale of short duration that attained hurricane force. No storm logs have as yet been received from any other vessel near the *Antinous*—and there were several not far away—although a heavy and confused sea was reported.

On the 25th the trade wind in the Caribbean Sea was unusually strong, as shown by report in table from the British S. S. *Ecuador*.

On the 25th a moderate disturbance was central near 53° N., 30° W., that moved slowly eastward, and on that date and the 26th westerly gales were encountered in the southerly quadrants.

On the 27th a depression with its center near 50° N., 40° W., was responsible for gales over a limited area. On the 28th westerly winds of gale force prevailed between the fifty-fifth and sixtieth parallels and the tenth and twentieth meridians, and on the 29th westerly winds of force 7 were reported by land stations on the west coast of Scotland, and also by vessels in the North Sea.

On the 30th there was a shallow depression near 40° N., 45° W., surrounded by winds of force 7 to 8, although no storm logs were rendered by the reporting vessels.

On the 31st westerly gales were reported from a limited area near Lerwick, as shown by report in table from the Danish S. S. *Frederik VIII*.

Three waterspouts were reported during the month, as follows:

American S. S. *Broad Arrow*, Capt. W. J. Vanden Heuvel; observer, P. H. Browne, Colon to New York:

> August 5, in 21° 49′ N., 74° 18′ W., 11 a. m. Waterspout formed about 2 miles astern of vessel. The funnel extended from clouds two-thirds of distance to water surface, and for distance of 150 feet upward from the sea appeared like heavy vapor rolling upward and outward. The funnel did not at any time connect with surface of the water so as to be visible to the naked eye. The center of the funnel appeared to be moving upward at a good rate. This lasted for about half an hour and then broke up. It traveled only about 4 miles to westward from the starting point. Barometer 30.16 inches, temperature of air 82°, sea 82°. Wind NE. 1, weather cloudy, Cu.-Nb. 8. Shortly afterwards heavy rain qualls, with thunder and lightning. Wind variable, 1 to 2, for 2½ hours.

American S. S. *Abron*, Capt. A. W. Pearson; observer, J. Wadden, second officer, Valencia, Spain, to New York:

> On August 7, at 3.48 p. m., in 36° 10′ N., 47° 28′ W., observed a large waterspout on starboard bow. It was descending from a black cloud and had a curved stem reaching down to the water. It remained stationary about 8 minutes and then slowly disappeared. Did not cause any change in the weather.

American S. S. *Hera*, Capt. A. F. Mellgard; observer, H. I. Christensen, Marseille to New York:

August 30, 2 a. m., in 35° N., 53° 15′ W. A large waterspout rising. In shape of inverted V until covering the moon and skies in the SW., then moving slowly to the south and east and then disappearing in a rain squall. During the time it was passing and making up the wind was calm. After passing, the sound of distant humming was heard. No water fell on or near ship. Time from beginning to breaking was about 2 minutes. Distance of vessel about 7 miles. Before and after passing, clear moonlight, gentle NW. breeze, moderate sea.

Ocean gales and storms, August, 1925

Vessel	Voyage		Position at time of lowest barometer		Gale began	Time of lowest barometer	Gale ended	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Highest force of wind and direction	Shifts of wind near time of lowest barometer
	From—	To—	Latitude	Longitude									
			° ′	° ′				Inches					
NORTH ATLANTIC OCEAN													
Manchester Merchant, Br. S. S.	Manchester	St. John, N. B.	50 20 N.	31 02 W.	3d	11 p. 3d	3d	29.54	N	N., 7	N	NW., 8	Steady.
Maine, Dan. S. S	Montreal	Copenhagen	57 10 N.	36 15 W.	6th	9 a., 6th	7th	29.29	N	N., 9	NNE	N., 9	N.-NNE.
Dania, Dan. S. S	Newcastle	Boston	50 00 N.	40 39 W.	6th	10 p. 6th	do	29.78	NW	NNW	N	NNW., 8	Steady.
Am. Shipper, Am. S. S	London	New York	48 08 N.	26 25 W.	10th	4 p. 11th	12th	29.72	SW	SW., 7	W	SW., 9	SW.-NW.
Hoosac, Br. S. S	Liverpool	Boston	49 40 N.	29 25 W.	19th	8 p., 19th	20th	29.57	SW	W., 10	NW	—, 11	SW.-W.
Antinous, Am. S. S	London	Mobile	34 38 N.	63 05 W.	20th	2:30 a. 20th	20th	29.34	SW	SW., 9	W	—, 12	4 pts.
Brit. Star, Br. S. S	Port Arthur	Southampton.	47 30 N.	22 54 W.	19th	3 a., 20th	20th	29.73	S	S., 7	NW	NW., 9	S.-NW.
Do	do	do	47 51 N.	15 56 W.	20th	4 p., 21st	22d	29.83	NW	NW., 9	NNW	NW., 9	NW.-NNW.
West Campgaw, Am. S. S.	Bremen	Philadelphia	49 00 N.	22 12 W.	22d	2 p., 22d	23d	29.62	W	W., 5	NNW	—, 8	W.-NW.
Bird City, Am. S. S	Copenhagen	Portland, Me	51 10 N.	40 58 W.	25th	5 p., 25th	29th	29.46	NW	NW., 8	NW	—, 8	NW.-NNW.
Ecuador, Am. S. S	New York	Canal Zone	13 00 N.	75 00 W.	24th	6 a., 25th	26th	29.79	ESE	NE., 7	NE	NE., 7	E.-NE.
Alberta, Ital. S. S	do	Gibraltar	40 20 N.	40 12 W.	27th	9 p.	27th	29.71	SE	SW., 8	W	SW., 9	SE.-S.-W.
Stockholm, Swed. S. S	Gothenberg	New York	57 46 N.	16 42 W.	27th	4 a., 28th	29th	29.40	SSW	SSW., 8	W	WSW., 10	SSW.-W.
Frederik VIII, Dan. S. S.	Oslo	do	59 20 N.	9 00 W.	31st	8 p., 31st	Sept. 2	29.70	WSW	WSW., 8	W	W., 8	WSW.-W.
SOUTH PACIFIC OCEAN													
Makura, Br. S. S	Papeete	Rarotonga	33 00 S.	174 00 W.	July 30	4 a., 31st	Aug. 2		ENE	E	ESE	ESE., 9	ENE.-ESE.
NORTH PACIFIC OCEAN													
West Calera, Am. S. S	Sydney, N. S. W.	San Francisco	15 55 N.	152 30 W.	July 31	6 a., 1st	1st	29.74	NE	NE., 8	E	NE., 9	
Vancolite, Can. S. S	San Pedro	Iquique	18 51 N.	105 27 W.	16th	5 p., 16th	17th	29.70	NE	NE., 3	ESE	ESE., 9	NE.-ESE.
West Cayote, Am. S. S	Japan	San Francisco	46 27 N.	173 34 E.	19th	midt 19th	22d	29.47	ENE	ENE., 7	SW	NE., 9	NE.-N.-NW.
West Prospect, Am. S. S	San Francisco	Japan	33 06 N.	136 30 E.	20th	7 a., 20th	21st	29.93	E	E., 10	E	E., 10	Steady.
West Carmona, Am. S. S.	do	Yokohama	47 30 N.	175 30 E.	28th	1 p., 29th	29th	29.42	S	SW., 8	NNW	SW., 8	SW.-WNW.
Yokohama Maru, Jap. S. S.	Yokahama	Victoria	43 26 N.	162 44 E.	28th	5 p., 29th	30th	29.37	SSW	S., 9	WSW	—, 10	SSW.-S.

NORTH PACIFIC OCEAN

By WILLIS EDWIN HURD

The eastern North Pacific high-pressure area was well established in August, as during several consecutive previous months. In fact, it was less disturbed by cyclones than is usually the case; hence generally settled weather and light winds prevailed over the greater part of the region between the Hawaiian Islands and the United States. Near the crest of the HIGH the pressure averaged about 30.40 inches—some 0.10 inch above the normal.

Results of this at Honolulu were: Fair days in exceptional number, wind directions almost entirely from the east, and, owing to the considerable gradient on the lower slope of the HIGH, a record average wind velocity for August of 11 m. p. h. The maximum velocity of 35 miles, from the east, on the 3d, equaled the previous record. Rainfall at Honolulu continued light, the total being only 0.18 inch, or 1.10 inches less than the normal. It was the second driest August on record.

There was some low pressure along the 50th parallel, but no pronounced cyclonic conditions until near the end of the month, when a rather intense LOW, apparently having moved from the eastern coast waters of Asia, was central near 50° N., 175° E., on the 29th, accompanied by gales, one vessel reporting a wind force of 10. It advanced into Bering Sea and lay over western Alaska on the 31st.

Pressure for the island stations in the eastern North Pacific, and for a few stations on the American coast, are given in the following table:

Station	Average pressure	Departure from normal	Highest	Date	Lowest	Date
Dutch Harbor [1]	(2)					
St. Paul [1]	[3] 29.82	+0.06	30.34	19th	29.22	30th
Kodiak [1]	29.83	+0.08	30.36	20th	29.56	31st
Midway Island [1]	[4] 30.03	−0.06	30.24	31st	29.90	7th
Honolulu [5]	29.99	−0.02	30.09	20th	29.87	24th
Juneau [5]	30.01	−0.01	30.25	15th	29.68	29th
Tatoosh Island [5]	[6] 30.05	0.00	30.33	3d	29.79	22d
San Francisco [5]	[6] 29.98	+0.04	30.14	20th	29.81	16th
San Diego [5]	[6] 29.93	+0.04	30.05	3d	29.82	16th

[1] P. m. observations only.
[2] Data missing.
[3] 26 days.
[4] 30 days.
[5] A. m. and p. m. observations.
[6] Corrected to 24-hour mean.

The minimum pressure readings in the Gulf of Alaska and lower Bering Sea stations occurred coincidentally with the highest reading at Midway Island.

Low pressure prevailed in the Far East, and considerable cyclonic activity occurred, though our available vessel reports from these waters give only meager indications of the extent and violence of the storms. A typhoon coming in from the ocean on the 17th caused several deaths in southern Japan, and wrecked houses in Osaka and other cities. The American steamer *West Prospect*, while not far from Yokohama on the 18th,

experienced the retreating southerly winds, force 7, of this storm, and checked speed to avoid possible trouble. But two days later, while en route toward China, in 33° 06′ N., 136° 30′ E., she ran into an easterly gale, force 10, of another typhoon, in which she hove to from 7 a. m. of the 20th until 5.30 p. m. of the 21st.

Further discussion of the storms of this region is found in the article by the Rev. José Coronas, S. J., at the end of this section.

In Mexican coast waters an apparently small and only moderately intense tropical cyclone occurred on the 16th. On that date the American steamer *Maricos H. Whittier* experienced a SE. wind, force 7, in 17° 15′ N., 106° 02′ W., at 6 a. m. At 5 p. m. the Canadian steamer *Vancolite*, northward bound, ran into a moderate gale, "wind increasing in squalls to force 9, ESE., barometer 29.79, heavy sea, vessel pitching and straining heavily, and shipping heavy water." This was in 18° 51′ N., 105° 27′ W.

The American steamer *West Calera*, Sydney, N. S. W., to San Francisco, reports a gale which, on account of its position and its attendant barometric depression, is of interest. The following is the account by the observer, Mr. A. Skjellerup.

On July 31, 1925, in latitude 15° 20′ N., longitude 152° 12′ W., encountered severe gale commencing at 2 p. m. with showers, squalls, and heavy swell from NE. The wind remained steady in direction and gradually increased till 7 a. m., August 1, when it reached force 9. Overcast and raining. At 11 a. m. wind veered to east, easing gradually from then to force 5 at 7 p. m. At 2 p. m., 31st, the barometer was 29.88, falling gradually till 6 a. m., 1st, when it was 29.74, from then commencing to rise slowly, reading 29.92 at 7 p. m.

Except as noted above, few and inconsequential gales seem to have occurred along the great northern steamship routes.

Fog, as in July, was frequent and heavy in upper latitudes, and several vessels en route there reported a continuance of it for days at a time. It also was observed on several dates along practically the entire American coast from northern Alaska to near Cape San Lucas.

American S. S. "Mexican," Canal to Los Angeles.—August 14, 12 noon, in 16° 12′ N., 99° 15′ W., passed a very large waterspout about 2 miles off. Two smaller ones near by had either just broken up, or were just about to form. Gentle E. breeze, cloudy (A.-Cu. and Cu.-Nb.), barometer 29.89, temperature of air 84°, of sea 78°.

INDIAN OCEAN

Observations covering a considerable part of August indicate that the southwest monsoon was especially strong in the Arabian Sea, being of force 8 on several days. The American steamer *Ensley City*, Shanghai to Calcutta, from August 2 to 16, reported "SW. monsoon winds very regular in south China Sea and Bay of Bengal, especially strong in latter."—*W. E. H.*

TWO JAPAN AND ONE FORMOSA TYPHOONS, IN AUGUST, 1925

By Rev. José Coronas, S. J.

[Weather Bureau, Manila, P. I.]

Although the rainfall in the Philippines during the past month of August has been quite above the normal, yet there was no real typhoon over the Philippine Archipelago in the whole month but only a low-pressure area covering the northern part of Luzon on the 29th. Three severe typhoons, however, were shown by our Weather Maps over the Far East, two over or near Japan and one close to north Formosa, although only that of Formosa influenced the weather in the Philippines. There was another typhoon near Guam at the end of the month, but its track belongs rather to the month of September. The low-pressure area of Luzon of the 29th moved on the 30th to the China Sea, where it developed into a depression or typhoon near the Paracels and probably filled up on September 2 near the Indo-China coast.

The first Pacific typhoon was probably formed on the 9th to 11th near 140° longitude E. and 15° latitude N. It moved first to NNW. and N. by W. and was met by the Japanese transport *Ondo* on her way from Tokio to Borneo, when she was in 134° 40′ longitude E. and 24° 30′ latitude N., her barometric minimum being 732 mm. (28.82 inches) at 8 a. m. of the 14th, and the winds blowing with hurricane force (11 Beaufort scale) from N. by E. While the barometer was rising after 8 a. m., the winds backed rapidly to NW., WNW., W., and WSW.

The typhoon moved practically to the north on the 16th and the morning of the 17th. After noon of the 17th it moved northeastward across the Sea of Japan. At 6 a. m. of the 17th the typhoon was over southwestern Japan. The approximate positions of the center at 6 a. m. of the 14th to 18th were as follows:

	Latitude	Longitude
	° ′	° ′
Aug. 14, 6 a. m.	24 05 N.	135 00 E.
Aug. 15, 6 a. m.	26 30 N.	134 20 E.
Aug. 16, 6 a. m.	29 10 N.	133 50 E.
Aug. 17, 6 a. m.	35 00 N.	133 10 E.
Aug. 18, 6 a. m.	44 40 N.	138 35 E.

The second Pacific typhoon appeared on our Weather Maps of the 17th to the ENE. of Guam, near 150° longitude E. and 17° latitude N. It moved W. by N. until the 23d, when it recurved to NNE. near 138° longitude and 19° latitude, increasing considerably its rate of progress after two days of a very slow movement. At 6 a. m. of the 24th its center was shown in our Weather Map about 115 or 120 miles to the west of the Bonins, where the barometer had fallen to 740 mm. (29.13 inches), with southeasterly winds, force 6. During the 24th and 25th the typhoon moved to NNW. and NW.; on the 26th it took again a NNE. direction and in the morning of the 27th it traversed central Japan, probably as only a depression and moving N., although in the afternoon of the same day it recurved to ENE., entering again the Pacific on the 28th.

The Formosa typhoon was probably formed on the 22d to 23d about 350 or 400 miles to the east of north Luzon. After remaining almost stationary or moving very slowly to WNW., NW., and N. on the 23d, the 24th, and the morning of the 25th, it increased its rate of progress in the afternoon of the 25th while moving NNE. about 300 miles to the east of Bashi Channel. But in the afternoon of the 26th it took almost suddenly a WNW. direction toward Meiacosima group of Islands and north Formosa. Its center passed over Meiacosima in the early morning of the 27th and very close to north Formosa in the afternoon of the same day. Two steamers were much involved in this typhoon near Formosa in the northern part of Formosa Channel—the Japanese steamer *Mayebashi Maru*, with barometric minimum 737.09 mm. (29.06 inches), wind NW. 10, at 3 p. m. of the 27th, in 120 34′ longitude E. and 25 24′ latitude N., and the American steamer *President Jefferson*, with a barometric minimum 743.75 mm. (29.28 inches), wind

NW. 8 at 2 p. m. of the 27th in about 120° 28′ longitude E. and 25° 43′ latitude N.

The approximate position of the center at noon of the 27th was 122° 20′ longitude E., 25° 20′ latitude N.

Once in China the typhoon recurved to the north and northeast on the 28th and 29th to the west of Shanghai and on the 30th it traversed Korea and the Sea of Japan, moving ENE.

DETAILS OF THE WEATHER IN THE UNITED STATES

GENERAL CONDITIONS

The month like its immediate predecessor was on the whole warm and dry. In the Southeast, the Southwest, and locally in some of the North Central States the drought of July was intensified with the result that a serious situation with respect to water for stock and even for domestic purposes obtained in many localities. The usual details follow.—*A. J. H.*

CYCLONES AND ANTICYCLONES

By W. P. DAY

Low-pressure areas were rather numerous, but none were important as storms with the exception of a very small disturbance which passed north of Bermuda on the 19th–20th. The latter attained nearly hurricane intensity over a short path northeast of Bermuda and was still in evidence on the 21st, south of Newfoundland.

High-pressure areas were about normal in number, but the majority, as in the preceding month, were of the so-called Alberta type. Five of the nine that were plotted carried through to the Atlantic coast, causing frequent alternations in temperature.

FREE-AIR SUMMARY

By V. E. JAKL

The average free-air temperatures at the aerological stations show about normal values at all altitudes, except at Ellendale and Due West, where a slight, rather uniform, positive departure with altitude was recorded. (See Table 1.) Free-air temperatures from day to day showed but slight variation, closely following the average daily surface temperatures in that respect. Notwithstanding the unusual dryness over considerable areas represented by aerological stations, relative humidities aloft showed no corresponding deficiency, except at Due West, where they were decidedly below normal at all altitudes observed.

The free-air tables for this month include for the first time meteorological data from airplane observations recently begun at the naval air station at Washington, D. C. (See Table 3.) As this method of observation does not include the recording of wind velocity and direction, that portion of the data in Table 3 pertaining to wind is taken from the results of pilot-balloon observations made simultaneously, or nearly so, at the central office of the Weather Bureau at Washington, D. C., a short distance from the naval air station.

The free-air temperature record for Washington shows an average lapse rate about six-tenths of the dry adiabatic, which was probably about normal, inasmuch as the other aerological stations show the usual lapse rate for the time of year, ranging from slightly less to slightly greater then the value for Washington. The following record of the naval air observation on the 20th may be of interest in connection with the thundershower that followed it in a few hours. The storm occurred soon after the surface wind changed to northwesterly from southerly.

Altitude m. s. l. (meters)	Temperature, °C.	$\frac{\Delta t}{100 \text{ m.}}$	Relative humidity (per cent)	Wind direction	Wind velocity (m. p. s.)
7	27.2		69	SSW.	1
408	29.0	−0.45	48	WSW.	9
1,685	17.3	0.92	85	WNW.	7
3,066	9.7	0.55	36	WNW.	13
3,375	7.9	0.58	44	WNW.	15

Due West shows the only important exception to a general state of normal winds for the month, the records of that station giving resultant winds of northeasterly component up to about 1,500 meters, as distinguished from the normal condition of northeasterly winds at the surface only. These northeasterly winds of moderate depth were the effect of a predominant pressure condition over Due West consisting of HIGHS with centers to the north and northeast. As a result dry weather continued over Due West with but little interruption.

At Ellendale on the 23d the highest surface temperature of record for August occurred at the afternoon maximum, although the record high temperature for August at 1,000 to 2,500 meters above sea level occurred in the early morning of that date. The rise of temperature to the high maximum in the lowest few hundred meters was accomplished by a few hours of insolation, aided by the strong chinook wind which blew during the morning in question and probably also during the preceding night. The influence of the chinook was strong aloft during the night, but it seems to have been largely offset at the surface by radiation. The development of the high surface temperature in this case differs from that noted for Broken Arrow in the June, 1925, Free-Air Summary, where the heating was attributed to the cumulative effect of insolation in connection with light winds to great heights. A LOW was centered north of Ellendale on the 22d and west of it on the 23d.

Altitude, m. s. l. (meters)	Temperature, °C.	Relative humidity (per cent)	Wind		Temperature, °C.	Relative humidity (per cent)	Wind	
			Direction	Velocity			Direction	Velocity
	Aug. 22				Aug. 23			
Surface (444)	18.5	70	S.	9	22.0	76	SSE.	8
1,000	21.4	39	SSW.	10	32.4	22	SW.	22
2,000	20.8	23	WSW.	8	23.8	21	SSW.	19
3,000	11.6	23	SW.	6	14.2	43	SSW.	16

The kite flight at Drexel on the 18th is an illustration of change in wind direction at the surface and aloft attending the passage southeastward over the station of the center of a weak low-pressure area. The inversion above 1,000 meters due to colder northeast wind underneath is apparent from the figures; also the change to a

southerly from a northerly component from 1,500 meters to above 2,000 meters, and an oppositely directed change at the surface. This flight was followed by a thunderstorm in the early morning of the following day.

Time	Surface wind		Altitude, m. s. l. (meters)	Temperature, °C.	Relative humidity (per cent)	Wind direction	Wind velocity, (m. p. s.)
	Direction	Velocity (m. p. s.)					
7:08 a. m.	SW.	6	500	22.4	70	SW.	17
7:18 a. m.	SW.	5	1,000	28.8	39	W.	11
7:30 a. m.	SW.	5	1,500	26.4	37	WNW.	11
7:40 a. m.	WSW.	5	2,000	22.3	43	WNW.	11
8:12 a. m.	WSW.	4	3,000	13.4	53	W.	12
9:05 a. m.	WSW.	4	4,000	5.0	44	W.	11
9:59 a. m.	W.	2	3,000	14.0	53	WSW.	12
10:13 a. m.	NNW.	2	2,000	22.4	47	SSW.	7
10:18 a. m.	N.	1	1,500	26.6	44	S.	7
10:25 a. m.	N.	1	1,000	23.3	74	NE.	7
10:28 a. m.	NNE.	1	500	28.6	65	NNE.	2

Easterly winds to high altitudes were of frequent and quite general occurrence during the last decade, more especially during the middle of this period. The central and eastern portions of the country were then largely under the influence of extensive, slow-moving HIGHS. The height to which these easterly winds were sometimes observed is shown in one case by the single-theodolite pilot-balloon observation at Groesbeck on the 7th, where an abrupt shift from west to east-northeast occurred at 10,000 meters, where cirrus clouds were observed moving from the latter direction. The wind continued from an easterly to northeasterly direction thereafter to the upper limit of observation at 13,400 meters. Also at Broken Arrow on the 18th, the two-theodolite observation to 14,300 meters showed generally easterly winds at all altitudes above 7,000 meters. However, the seasonal recedence of the conditions causing prevailing easterly winds to high altitudes is already apparent in the records for August in the fact that resultant winds having an easterly component were only slightly in evidence at any of the southern stations north of Key West, and at the latter station were evident principally in the records of the morning observations. At San Juan, P. R., and Kingston, Jamaica, the easterly component was persistent, the records for those stations showing easterly winds on every day and at practically every altitude observed.

TABLE 1.—*Free-air temperatures, relative humidities, and vapor pressures during August, 1925*

TEMPERATURE (°C)

Altitude m. s. l. (meters)	Broken Arrow, Okla. (233 m.)		Drexel, Nebr. (396 m.)		Due West, S. C. (217 m.)		Ellendale, N. Dak. (444 m.)		Groesbeck, Tex. (141 m.)		Royal Center, Ind. (225 m.)	
	Mean	Departure from 8-yr. mean	Mean	Departure from 10-yr. mean	Mean	Departure from 5-yr. mean	Mean	Departure from 8-yr. mean	Mean	Departure from 7-yr. mean	Mean	Departure from 8-yr. mean
Surface	26.3	−0.7	22.6	0.0	27.4	+1.4	21.5	+0.9	27.2	+0.2	23.1	−0.6
250	26.3	−0.6			27.0	+1.4			26.2	+0.1	22.9	−0.6
500	25.8	+0.2	21.9	−0.2	24.1	+1.1	21.6	+1.1	24.1	−0.2	21.0	−0.3
750	24.8	+0.4	21.2	−0.1	22.1	+0.8	20.6	+1.0	23.2	−0.1	19.5	−0.1
1,000	23.5	+0.4	20.3	0.0	20.4	+0.7	20.1	+1.6	22.4	+0.1	17.7	−0.3
1,250	21.9	+0.3	19.1	0.0	18.7	+0.5	19.1	+1.9	21.0	0.0	16.2	−0.3
1,500	20.1	+0.1	17.9	+0.1	17.2	+0.5	17.5	+1.8	19.5	−0.1	15.0	−0.1
2,000	16.4	0.0	14.8	0.0	14.8	+1.0	14.3	+1.5	16.4	−0.3	11.9	−0.4
2,500	12.4	−0.5	11.5	−0.1	12.2	+1.5	10.8	+1.0	13.4	−0.4	9.0	−0.7
3,000	8.9	−0.8	8.5	+0.3	8.9	+1.2	7.5	+0.6	10.3	−0.8	5.9	−1.1
3,500	5.7	−0.6	5.7	+0.8	5.4	+0.8	4.6	+0.6	6.6	−2.0	1.9	−2.3
4,000	3.4	+0.2	2.7	+1.1	2.0	+0.8	2.0	+0.8	2.9	−2.9	−0.6	−2.1
4,500	0.4	+0.5	0.8	+2.2			−0.9	+1.0			−2.3	−1.5
5,000			−2.0	+2.5								

RELATIVE HUMIDITY (%)

Altitude m. s. l. (meters)	Broken Arrow Mean	Departure	Drexel Mean	Departure	Due West Mean	Departure	Ellendale Mean	Departure	Groesbeck Mean	Departure	Royal Center Mean	Departure
Surface	61	−4	69	−1	53	−14	58	−6	69	−4	66	+1
250	61	−4			53	−14			71	−3	66	+1
500	56	−6	67	0	56	−14	56	−6	74	0	65	0
750	54	−6	63	+1	57	−14	52	−6	67	−1	65	−1
1,000	53	−6	61	+1	57	−15	49	−7	59	−3	67	+1
1,250	55	−4	61	+2	56	−16	47	−8	59	−1	66	0
1,500	57	−2	61	+3	53	−18	48	−7	60	0	63	−2
2,000	60	−1	61	+3	50	−17	48	−5	62	+3	61	0
2,500	66	+4	56	−1	46	−20	49	−2	62	+5	44	−11
3,000	61	+1	48	−9	44	−22	48	−2	64	+10	47	−3
3,500	59	0	43	−13	49	−18	42	−5	62	+14	46	0
4,000	53	−6	34	−18	60	−9	36	−10	63	+22	48	0
4,500	51	−7	32	−20			34	−11			38	−10
5,000			32	−21								

VAPOR PRESSURE (*mb.*)

Altitude m. s. l. (meters)	Broken Arrow Mean	Departure	Drexel Mean	Departure	Due West Mean	Departure	Ellendale Mean	Departure	Groesbeck Mean	Departure	Royal Center Mean	Departure
Surface	20.58	−2.09	18.55	−0.24	18.56	−3.61	14.20	−0.77	24.56	−0.74	18.85	−0.18
250	20.42	−1.83			18.20	−3.64			23.89	−0.61	18.62	−0.19
500	18.56	−1.35	17.46	−0.30	16.42	−3.12	13.72	−0.91	21.98	−0.24	16.30	−0.30
750	16.75	−1.14	15.63	−0.09	14.96	−2.94	12.05	−0.99	18.82	−0.39	14.65	−0.53
1,000	15.34	−0.98	14.20	−0.01	13.42	−2.99	10.94	−0.87	15.67	−0.86	13.54	−0.45
1,250	14.29	−0.63	13.05	+0.08	11.78	−3.13	9.80	−0.91	14.26	−0.64	12.23	−0.53
1,500	13.29	−0.29	12.06	+0.25	10.10	−3.20	9.07	−0.68	13.32	−0.39	10.73	−0.68
2,000	11.19	−0.04	9.85	+0.05	8.27	−2.20	7.62	−0.28	11.28	−0.02	8.17	−0.72
2,500	9.23	+0.22	7.22	−0.69	6.61	−1.90	6.21	−0.19	9.30	−0.01	3.97	−2.72
3,000	6.47	−0.48	5.14	−1.22	5.23	−1.72	4.99	−0.25	8.14	+0.53	3.04	−1.90
3,500	4.72	−0.57	3.86	−1.22	4.40	−1.25	3.64	−0.58	6.72	+0.78	1.60	−2.13
4,000	3.22	−0.79	2.59	−1.26	4.40	−0.31	2.79	−0.69	5.90	+1.38	0.99	−2.15
4,500	1.98	−0.76	2.34	−0.82			2.21	−0.64				
5,000			2.20	−0.38								

TABLE 2.—*Free-air resultant winds (m. p. s.) during August, 1925*

Altitude, m. s. l. (meters)	Broken Arrow, Okla. (233 meters)				Drexel, Nebr. (396 meters)				Due West, S. C. (217 meters)			
	Mean		8-year mean		Mean		10-year mean		Mean		5-year mean	
	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.
Surface	S.	3.9	S. 1°W.	3.5	S. 12° E.	1.6	S. 14° E.	1.6	N. 25° E.	1.8	N. 26° E.	0.2
250	S.	4.2	S. 1°W.	3.7					N. 21° E.	1.8	N. 15°W.	0.2
500	S. 11°W.	6.5	S. 12°W.	5.4	S. 20° E.	3.8	S. 10° E.	2.3	N. 29° E.	2.4	N. 26°W.	0.5
750	S. 20°W.	7.2	S. 19°W.	6.0	S. 16°W.	4.7	S. 5°W.	3.3	N. 22° E.	2.5	N. 36°W.	0.7
1,000	S. 29°W.	7.0	S. 27°W.	6.3	S. 22°W.	5.6	S. 22°W.	3.6	N. 21° E.	2.7	N. 31°W.	0.7
1,250	S. 34°W.	6.4	S. 34°W.	6.0	S. 29°W.	5.8	S. 45°W.	3.3	N. 9° E.	2.2	N. 53°W.	1.0
1,500	S. 43°W.	6.6	S. 40°W.	5.9	S. 40°W.	5.6	S. 49°W.	4.1	N. 2° E.	2.7	N. 68°W.	1.6
2,000	S. 45°W.	6.2	S. 45°W.	5.2	S. 48°W.	4.7	S. 64°W.	5.0	N. 12°W.	3.2	N. 66°W.	2.5
2,500	S. 41°W.	6.9	S. 48°W.	5.4	S. 58°W.	4.4	S. 72°W.	6.4	N. 12°W.	2.9	N. 71°W.	3.4
3,000	S. 36°W.	7.5	S. 47°W.	6.0	S. 79°W.	4.1	S. 81°W.	8.2	N. 36°W.	3.1	N. 80°W.	4.8
3,500	S. 32°W.	7.7	S. 42°W.	6.9	S. 74°W.	4.3	S. 82°W.	9.4	N. 85°W.	7.2	S. 89°W.	7.6
4,000	S. 30°W.	7.9	S. 48°W.	8.1	S. 59°W.	6.5	S. 86°W.	10.6	W.	9.7	N. 88°W.	9.1
4,500	S. 33°W.	9.9	S. 48°W.	8.2	S. 82°W.	8.5	N. 75°W.	10.0				
5,000					S. 65°W.	7.2	N. 76°W.	10.3				

Altitude, m. s. l. (meters)	Ellendale, N. Dak. (444 meters)				Groesbeck, Tex. (141 meters)				Royal Center, Ind. (225 meters)			
	Mean		8-year mean		Mean		7-year mean		Mean		8-year mean	
	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.
Surface	S. 7°W.	1.7	S. 35°W.	0.9	S. 13°W.	2.4	S. 15°W.	3.0	S. 63° E.	0.2	S. 60°W.	1.4
250					S. 16°W.	3.6	S. 17°W.	4.1	S. 27° E.	0.2	S. 62°W.	1.5
500	S. 7°W.	2.4	S. 30°W.	1.4	S. 17°W.	4.7	S. 22°W.	5.7	S. 62°W.	1.7	S. 65°W.	3.3
750	S. 27°W.	4.3	S. 35°W.	2.4	S. 14°W.	5.5	S. 20°W.	5.9	N. 79°W.	2.7	S. 72°W.	4.3
1,000	S. 33°W.	4.9	S. 46°W.	2.8	S. 4°W.	5.0	S. 20°W.	5.8	N. 87°W.	3.4	S. 79°W.	5.4
1,250	S. 38°W.	5.0	S. 54°W.	3.1	S. 13°W.	4.0	S. 18°W.	5.4	S. 87°W.	4.5	S. 83°W.	6.1
1,500	S. 47°W.	5.9	S. 58°W.	3.9	S. 22° E.	3.5	S. 16°W.	4.7	N. 86°W.	5.2	S. 87°W.	6.8
2,000	S. 51°W.	7.4	S. 78°W.	4.8	S. 33° E.	3.8	S. 7°W.	4.0	N. 83°W.	5.9	S. 88°W.	7.8
2,500	S. 64°W.	9.3	S. 88°W.	8.8	S. 28° E.	3.6	S. 7°W.	3.9	N. 77°W.	9.2	N. 87°W.	9.3
3,000	S. 66°W.	10.9	N. 87°W.	8.5	S. 25° E.	3.5	S. 11°W.	4.1	N. 77°W.	9.9	N. 85°W.	10.8
3,500	S. 82°W.	13.2	N. 82°W.	11.4	S. 19°W.	4.2	S. 14°W.	5.0	N. 77°W.	10.8	N. 88°W.	10.9
4,000	S. 87°W.	12.2	N. 80°W.	11.9	S. 22°W.	5.0	S. 3° E.	3.4	N. 83°W.	13.7	S. 89°W.	12.6
4,500	S. 78°W.	12.1	N. 79°W.	11.8					N. 45°W.	17.0	N. 86°W.	11.5
5,000	W.	19.0	N. 83°W.	13.3								

NAVAL AIR STATION, D. C.

Table 3.—*Mean free-air temperature, humidity, and vapor pressure and resultant wind (m. p. s.) during August, 1925, at Washington, D. C.*

Altitude m. s. l. (m.)	Naval Air Station (7 m.)			Weather Bureau (34 m.)	
				Wind	
	Temperature ° *C.*	Relative humidity %	Vapor pressure (mb.)	Direction	Velocity
Surface	22.4	79	21.52	N. 27° W.	0.7
250	21.9	71	18.60	N. 38° W.	1.3
500	22.1	65	17.18	N. 53° W.	1.5
750	20.9	65	16.04	N. 50° W.	1.4
1,000	19.4	67	15.03	N. 58° W.	1.5
1,250	17.9	68	13.93		
1,500	16.0	69	12.83	N. 36° W.	2.2
2,000	13.2	68	10.56	N. 31° W.	3.3
2,500	10.4	61	7.96	N. 38° W.	3.8
3,000	7.4	57	5.97	N. 47° W.	4.4
3,500	3.6	58	4.23	N. 60° W.	5.1
4,000	−0.2	66	3.51	N. 62° W.	5.3
4,500	−2.0	46	1.57	S. 87° W.	5.5
5,000	−3.8	39	0.85	N. 81° W.	6.5

THE WEATHER ELEMENTS

By P. C. Day, in Charge of Division

PRESSURE AND WINDS

The important feature in the distribution of the mean atmospheric pressure was the distinct upbuilding of the high pressure area usually existing over the Southeastern States, and its northward extension into the Great Lakes region, New England and the Canadian Maritime Provinces. In fact the pressure for the month was distinctly of the anticyclonic type, an unusual number of high areas entering the country from the Canadian Northwest, and persisting for rather lengthy periods over the more eastern districts, particularly during the last decade.

Cyclones were, as usual in summer, mainly of slight intensity, and those maintaining their identity over any extensive tracks were confined largely to the more northern districts.

The only important cyclone to traverse the interior districts had its origin in the far Southwest and assumed definite proportions by the morning of the 11th, when it was central over Kansas. During the following three days it moved slowly Northeastward to southern New England, attended by precipitation over considerable areas near its center, the falls being heavy in portions of Iowa, Illinois and Missouri, moderate in some near-by localities, and generally light to the eastward.

Average pressure was above normal over the entire United States, save for a small area in the far Northwest, and in Canada also except over small areas near the borders of Montana and North Dakota. Over all central and eastern districts it was well above the normal.

Compared with July pressures, those for August were higher over all southern, and most central and eastern districts, and in Canada from the Great Lakes eastward, the excesses over the July values being unusually large for a summer month in the Great Lakes, St. Lawrence Valley and near-by areas. In the Northwestern districts and over western Canada the August averages were materially lower than those for July.

Winds were mainly light, a number of stations reporting the least total movement of record for August, and in some cases less movement than for any previous month.

The usual number of local high winds associated with thunderstorms occurred, though loss of life and damage to property were mainly less than frequently happens in August.

Since the center of high pressure was over the middle Appalachian Mountain region, the wind circulation over the eastern third of the country conformed mainly to that usual in anticyclonic areas, from the Northeast over the Atlantic coast districts, easterly in the Gulf States, southerly in the middle Mississippi Valley; and south to southwest in the Great Lakes region. Between the Mississippi Valley and the Rocky Mountains the prevailing winds were almost uniformly from the south. In the far West, particularly along the California coast, where in August the winds are mainly strong from the northwest, this month they were frequently from the south or southwest, and generally light.

The important details of the principal wind, hail, or other storms are given in the table following this section.

TEMPERATURE

There were few important rapid temperature changes, though there were some unusually heated periods, and others that were distinctly cool, but these were the result mainly of gradual heating or cooling.

The first few days were moderately cool from the Rocky Mountains eastward; in fact over portions of the Middle Plains the first was the coldest day of the month, in a few sections the coldest of record so early in August. At the same time some of the highest temperatures were experienced in the far West. For the week ending the 11th temperatures were mainly moderate, though above normal generally over the northern and eastern districts and below in the Southwest.

The week ending the 18th was on the whole warmer than normal from the Great Plains eastward, the excesses becoming greater toward the south. In the far West, particularly over the Plateau, this week was distinctly cool. The week ending the 25th continued warm during the greater part over the central and eastern districts, the 19th and 20th being excessively warm over the Southeastern States where the maximum temperatures, ranging up to 110°, were in many cases the highest ever experienced in August, and in some cases higher than for any previous month. In the far West this week was moderately cool, freezing temperatures being reported from exposed points in Idaho and Oregon.

The last week was mainly warmer than normal between the Appalachian and Rocky Mountains, and cooler in the Plateau and Southwest, and over the Atlantic and Gulf coast districts, the coolest weather of the month occurring about the 28th in portions of the North Atlantic States.

The average temperature as a whole was above normal over the Great Lakes, the central valleys and most of the Southern States from Texas eastward, though the excesses were mainly small. The month was moderately cooler than normal from the central portions of Texas, Oklahoma, and Kansas westward, generally over the Plateau and Pacific States, and locally near the middle Atlantic coast.

Maximum temperatures reached 100° or more at some time during the month in practically all except the northeastern States, the highest reported, 120°, occurring in southern California. They reached 113° in Arizona, 112° in Nevada and Texas, and 110° in Georgia. The most extensive warm period was about the 17th to 20th, when temperatures in excess of 100° were experienced generally from the middle and southern plains eastward to the Atlantic coast.

The coolest periods were on the 1st in portions of the central valleys, but mainly during the last decade over the remaining portions of the country. Readings below freezing were reported in all the northern border states. The lowest observed was 14° in the mountains of Oregon.

PRECIPITATION

August was, for most of the country, one more dry month in a year in which, up to date, months of well distributed and ample rainfall have been few.

The regions west of the Rocky Mountain Divide had usually more rainfall than normal, with comparatively good distribution, although amounts were especially large for the region in a few localities, causing damage by flood. The northern part of the eastern slope of the Rockies was well watered, likewise much of the southern Plains and of the middle Mississippi Valley.

The Plains from central Nebraska northward had a considerable shortage as had most of Oklahoma and central and eastern Texas, while nearly all the eastern half of the country had a decided deficiency.

The drought in August was remarkably severe in the southern Appalachian region, including the western portions of the Carolinas, the eastern two-thirds of Tennessee, and the northern two-thirds of Georgia. In this region July had been comparatively dry, and remarkably so in western North Carolina. As a result the most serious drought within the memory of old people prevailed widely as August ended, many deep wells having failed, small streams being dry where never so known before, rivers being at extremely low stages, and hydroelectric service greatly restricted.

The average rainfall at points in Alabama was the least for August since the weather service was organized, more than 50 years ago. The shortage was well marked throughout the lower Mississippi Valley, and thence north to southwestern Missouri, also northeast to western Pennsylvania.

In Minnesota and northwestern Iowa and thence eastward to include northern Michigan, except the immediate shore of Lake Superior, there was likewise remarkably little precipitation and forest fires were unusually troublesome for August. In nearly all of New York and New England August was a remarkably dry month, but here July had generally brought ample rain, save in Maine, so usually conditions were not unfavorable. From southern Massachusetts to northern Florida the majority of the coast districts had considerable rain, though almost nowhere as much as normal.

The one eastern district of marked excess was in the Florida Peninsula, where numerous stations had twice their usual large August falls, one station in Dade County recording 17.56 inches.

The year 1925 to date has been marked by prolonged dryness over practically all the Gulf States and large areas to the northeast. In Texas every month of 1925 to date has averaged drier than normal and from Louisiana to Alabama and the eastern portions of Tennessee, northern Georgia, and the western portions of the Carolinas and Virginia every month except January. Likewise toward the northeast as far as the southern lake region each state shows six or seven months out of the eight from January to August, inclusive, deficient in precipitation.

In Arkansas and Tennessee the average deficiency for each State for the eight-month period is about 13 inches, and in Louisiana, Mississippi and Alabama over 10 inches, while over the western third of North Carolina it is almost 18 inches.

RELATIVE HUMIDITY

The percentages of relative humidity were less than normal over nearly all portions of the country from the Great Plains eastward, the principal exceptions being locally over a narrow area from the lower Mississippi Valley northeastward to the Great Lakes. From central Texas and the southern Plains eastward to the Atlantic Coast it ranged from 15 to nearly 30 per cent less than normal.

SEVERE LOCAL HAIL AND WIND STORMS, AUGUST, 1925

The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A more complete statement will appear in the Annual Report of the Chief of Bureau]

Place	Date	Time	Width of path, yards [1]	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Fleming, Colo. (near)	1	P. m.				Hail and wind	Trees, fences and several barns blown down; some crop damage.	Official, U. S. Weather Bureau.
Dallas County, Iowa	2					Hail	Character of damage not reported	Do.
Beaver County, Okla	3		4 mi.			Destructive hail	Heavy loss of crops; residences and other buildings damaged; poultry and cattle killed. Path 8 miles long.	Do.
Clark, Fayette and Bourbon Counties, Ky.	3				$125,000	Hail	About 300 acres of tobacco destroyed and corn damaged.	Do.
Berlin, N. H.	3	12.45-1.20 p.m.	2 mi.		15,000	Severe hail	Crops and windows badly damaged	Do.
Detroit, Mich	3					Violent hail, rain and thunderstorm.	Streets and basements flooded in some places to a depth of 18 inches.	Indianapolis Star.
Indianapolis, Ind	3	3.33 - 5.55 p. m.				Thunderstorm and hail.	Traffic demoralized for more than an hour; foliage shredded; 1 person injured.	Official, U. S. Weather Bureau; Indianapolis Star.
Tampa, Fla. (west of)	3	5.25-8 p. m.				Violent thunderstorm.	No damage reported	Official, U. S. Weather Bureau.
Greensburg, Pa	3	9 p. m.				Thunderstorm	Building excavation flooded; other minor damage.	Do.
Lincoln County, Wis.	4	11 a. m.-2 p. m.	3 mi.		50,000	Heavy hail	Growing crops badly damaged	Do.
Humboldt County, Iowa	4	3.30 p. m.	2 mi.			Hail	Corn damaged 80 per cent in places	Do.
Sarasota Beach, Fla.	4	5 p. m.				Small tornado	Two portable houses and a garage leveled; other minor damage.	Do.
Pittsfield, Wis	4	5 p. m.	880		75,000	Heavy hail	Damage principally to growing crops	Official, U. S. Weather Bureau.
Mower County, Minn. (central part of).	4	P. m.				Hail	Much damage to corn stripped by hail	Pioneer Press (Minneapolis, Minn.).
Raleigh, N. C., and vicinity	4					Thunderstorm and high wind.	Telephone poles, chimney, and buildings of light construction damaged. Crops and fruit suffer from high wind.	Official, U. S. Weather Bureau.

[1] "Mi." signifies miles, instead of yards.

Severe local hail and wind storms, August, 1925—**Continued**

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Fowler, Colo	5		1,760		$4,000	Hail	Vine crop and corn damaged	Official, U. S. Weather Bureau.
Hocking County, Ohio	5		880		15,000	do	Severe crop and property damage over path 10 miles long.	Do.
Moores Hill, Ind	5					Heavy hail	Corn and tobacco considerably injured	Do.
Williamstown, Ky	5					Hail	Local crops damaged	Do.
Watertown, N. Y	5	1.10 p. m.	1,760		10,000	Heavy hail	Corn, oats, and potatoes injured	Do.
Pontiac, Ill. (near)	7	4 p. m.				Hail	Character and amount of damage not reported	Do.
Dauphin County, Pa	8					Series of violent thunderstorms.	Considerable damage by flooding	Do.
Mechanicsville, Md. (near)	8					Thundergusts	Trees uprooted; tobacco and corn blown down	Do.
Roland, Iowa	8	P. m.				Hail	Corn damaged	Do.
Washington County, Md	8					Electrical	A barn destroyed and a cow killed near Smithburg; water tower and house damaged in Hagerstown; 1,200 telephones out of commission.	Do.
Hardin County, Iowa	8	5 p. m.				Hail	Crop loss about 10 per cent	Do.
Harrisburg, Pa	8	5.37 p. m.				Thunderstorm and excessive rain.	Many cellars and store basement flooded	Do.
Altenwald, Pa. (near)	8	6.30 p. m.	1,320		13,000	Small tornado with heavy hail.	Crop damage estimated at $10,000. Property damage small.	Do.
Rockwood, Calif	9				50,000	Two tornadoes	Eighteen buildings lifted from foundations; five persons injured.	Morning Sun (Yuma, Ariz.).
Talbot County, Md	9				6,000	Thundergusts	Boat house on Miles River damaged; tenant house and a barn at Oxford, and a canning house at Bozman destroyed. Much corn blown down.	Official, U. S. Weather Bureau.
Dodson, La. (near)	9	5-6 p. m.		1		Electrical	Several persons shocked and two houses set fire by lightning.	Do.
Henderson County, Ill	9	4 p. m.			400,000	Hail	Damage principally to growing crops but some to roofs and windows.	Do.
San Joaquin Valley, Calif. (west side of).	10					Thunderstorm	Oil reservoir at Coalinga struck by lightning resulting in a loss estimated at more than a million and a half dollars.	Do.
Otsego and Delaware Counties, N. Y. (sections of).	10	P. m				Rain, hail and wind.	Oats, corn and other crops flattened; one barn and contents valued at $10,000 burned; farm buildings and trees damaged.	Oneonta Star (N. Y.).
Sharon Springs, N. Y	10	2 p. m.	1,320		10,000	Heavy hail and wind.	Buildings blown down, windows broken; large acreage of oats and buckwheat destroyed; some corn and gardens damaged; total loss of much fruit.	Official, U. S. Weather Bureau.
Charles County, Md. (between Lothair and Piecowaxen Creek).	11	1-3 a. m.	1,760		16,000	Moderate hail and and thunderstorm.	One house and two barns unroofed; much crop damage.	Do.
Jennings, Kans. (near)	11	3.30 p. m.	1,760		10,000	Violent wind and hail.	Several buildings damaged by wind; corn and field crops injured by hail.	Do.
Covington, Tenn. (near)	11			1		Wind	No property damage reported	Do.
Otero and Bent Counties, Colo.	12	5-6 p. m.	1-2 mi.		80,000	Hail	1,500 acres of cantaloupes and melons, and considerable acreage of sugar beets, cucumbers, corn and seed alfalfa destroyed; vines torn.	Do.
Terre Haute, Ind	12	5.30 p. m.				Thunderstorm	Basements flooded in some sections, trees, signs, etc., blown down; electric service impaired.	Do.
Reno and Sedgwick Counties Kans.	12	8-9 p. m.	5 mi.		500,000	Violent wind and hail.	Many buildings damaged; crops damaged about 50 per cent by stones some of which were 5 inches in diameter.	Do.
Lincoln and Taylorville, Ill. (near).	12					Electrical	Barns burned by lightning	Do.
Rush County, Kans	12	P. m	1-3 mi.			Violent wind and hail.	Farm buildings and crops damaged	Do.
Paris, Ill. (vicinity of)	12	do				Wind, rain and hail.	Fields and basements flooded; corn prostrated	Chicago American.
Ardmore, Okla	12	do				Wind	Two persons injured and several residences damaged.	Official, U. S. Weather Bureau.
Denton, Tex	13	4.30-6 p.m.			75,000	Heavy hail	Crops almost totally destroyed; considerable damage to trees, buildings and shrubs.	Do.
East Waco, Tex	13	P. m	100			Tornadic wind	Houses unroofed; trees blown down; other minor damage.	Dallas Morning News, (Tex.).
Ferris, Tex., and vicinity	13					Electrical and rain	One barn damaged and one a total loss: two mules killed and one crippled; one person injured.	Do.
Gem and Twin Falls Counties, Idaho.	13					Hail	Heavy property and crop damage; poultry killed. Total amount of damage unestimated but there was $40,000 to $50,000 damage 3 miles south of Emmett.	Official, U. S. Weather Bureau.
Atlanta, Ga	14	2.38 p. m.			1,000	Wind	Poles prostrated; plate glass windows broken	Do.
Jacksonville, Fla	14					Thunderstorm and wind.	Two persons injured, one seriously. No property damage reported.	Do.
Nashville, Tenn	14					Thunderstorm	Many telephones out of use; street car service impaired.	Do.
Nashville and Louisburg, N. C.	14	P. m.			50,000	Heavy hail	Crops damaged	Do.
Raleigh, N. C	14					Thunderstorm and wind.	Trees broken and power and light service interrupted.	Do.
Seguin, Kans	14	P. m.				Small tornado	One church and several barns demolished; many cattle and other stock killed by lightning.	Official, U. S. Weather Bureau; Kansas City Star.
Uniontown, Ala., and vicinity.	14		1,760			Heavy hail and high wind.	Considerable damage, character of which was not reported.	Official, U. S. Weather Bureau.
Glen Cove, N. Y., and vicinity.	14	6-8 p. m.				Hail	Electric system disabled; display window of department store destroyed.	New York Times.
Pottawattomie County, Ia	16	12.30 p. m.	3 mi.		75,000	do	Corn severely damaged	Official, U. S. Weather Bureau.
Detroit, Minn., and vicinity north and west of.	16					Severe wind and hail.	Several buildings damaged; trees blown down; crops flattened; electric power service interrupted.	Fargo Forum (N. Dak.).
La Prairie, Ill	18	1 a. m.	440			Hail	Slight damage	Official, U. S. Weather Bureau.

Severe local hail and wind storms, August, 1925—Continued

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
From Poweshiek County southeast through Iowa, Keokuk, Washington, Jefferson, Henry, Des Moines and Lee Counties, Iowa.	18	9 a. m.	6-10 mi.		$2,500,000	do	Very heavy damage over large area. Poultry and stock injured or killed; path 75 miles long.	Official, U. S. Weather Bureau.
Parts of Hancock, Henderson, McDonough and Schuyler Counties, Ill.	18	11 a. m.-noon.			510,000	Hail and wind	Heavy crop and property damage; some poultry killed. Damage in Schuyler not included in estimate.	Do.
Chattanooga, Tenn	18	1.40 p. m.				Thunderstorm	Slight damage to bridge	Do.
Murphysboro, Ill	18	3.30 p. m.	880		11,000	Wind	School building badly damaged; other minor damage.	Do.
Cairo, Ill., and vicinity	18	5.20 p. m.			2,200	do	Several hay barns blown down	Do.
Quincy, Ill	18	9-9.25 p.m.				do	Gardens and trees damaged	Do.
Pierre, S. Dak	19	8.44-11.50 a. m.				Violent thunderstorm.	Some damage by lightning	Do.
Keokuk and Washington Counties, Iowa.	19	9 a. m.				Hail	Occurred in portions of the same area covered in the storm of the 18th. Slight damage added.	Do.
La Harpe, Hancock County, Ill.	19	11.30 a. m				do	Storm less destructive than the one in Hancock County on the 18th.	Do.
Pekin and Peoria Counties, Ill.	19	1.10 p. m.	10 mi.		20,000	Wind and hail	Some damage by hail	Do.
Vermilion County, Ill. (in and near).	19	3.30 p. m.	5 mi.			do	Corn damaged by hail north of Danville	Do.
Booneville, Ind. (near)	19				4,500	Heavy hail	Much tobacco ruined	Do.
North and central New York	19	P. m			115,000	do	Some crops entirely destroyed; buildings, trees, and wire systems damaged. Heaviest damage at Tupper Lake, Clayville, and Herkimer.	Do.
Harrisburg, Pa., and vicinity	19					Thunderstorm, wind and hail.	Poles blown down, obstructing traffic; corn and other crops injured by hail.	Do,
Montgomery and Henry Counties, Tenn.	19				100,000	Wind and hail	Seven hundred acres of fine tobacco practically ruined by hail, some additional damage by wind.	Do.
Louisville and Jefferson Counties, Ky.	19					Wind	Trees, wire systems and windows damaged	Do.
Nashville, Tenn., and west of.	19					Thunderstorm, and wind.	One chimney and a number of trees blown down; other minor damage west of city.	Do.
Berlin, N. H	19	Noon			20,000	Thunderstorm	Much damage from water	Do.
Montgomery County, Ind. (north part of).	19	P. m.				Wind	Property damage in Darlington and Crawfordsville considerable.	Do.
Wagoner, Okla	20	2.15 p. m.				do	Roof and one wall of large garage blown in	Do.
Haskell, Okla	20					Small tornado	Several small buildings wrecked; tent blown down and benches carried several blocks.	Oklahoman (Oklahoma City, Okla.).
Henryetta, Okla	20					Tornado, wind, and rain.	Several automobiles damaged	Do.
Johnson City, Tenn	20			1		Electrical	Small child killed by lightning	Official, U. S. Weather Bureau.
Veedersburg, Ind	20				5,000	do	A garage and barn struck by lightning and burned, killing a horse and destroying many farm implements.	Do.
Savannah, Ga	21	4.17 p. m.				High wind	Warehouses damaged; overhead wires broken; trees uprooted.	Do.
Thrall, Tex. (east of)	21	5.30 p. m.				Small tornado	Two barns unroofed and several small houses blown from foundations.	Taylor Daily Express (Tex.).
Andalusia, Ala	21			1		Electrical	One person killed by lightning	Official, U. S. Weather Bureau.
Blakely, Ga	21				1,000	Thunderstorm	Poles blown down and a few houses damaged	Do.
Christian County, Ky	21				25,000	Hail	Four hundred fifty acres of tobacco damaged 25 per cent.	Do.
Echeconne, Ga	21				200	Wind	Two small houses damaged	Do.
Kenton, Okla	21					Hail	Slight damage	Do.
Leesburg, Ga	21			3		Thunderstorm	No property damage reported	Do.
Sale City, Ga	21			3		do	do	Do.
Southport, N. C	21					Hail	Slight damage as most crops were housed or partly matured.	Do.
Seabrook, Tex	22	10.15 p. m.	100-400	2		Tornadic wind	Many camps and shacks wrecked; 10 persons injured; path 2 miles long.	Official, U. S. Weather Bureau; Shreveport Times (La.).
Fort Lupton, Colo	23	7 p. m.				Hail	All crops over a path 4 to 5 miles suffered	Official, U. S. Weather Bureau.
Calipatria, Calif	25	do		1	100,000	Violent wind	Warehouse and dwellings on east side of town torn from foundations; Southern Pacific station cut in half.	Los Angeles Times (Calif.).
Columbia, Ky	25				5,000	Hail	Much tobacco destroyed and corn injured	Official, U. S. Weather Bureau.
Lake Michigan	26			4		High winds	No property damage reported	New York Daily News.
Statesboro, Ga	26				500	Wind and hail	Some damage to unpicked cotton	Official, U. S. Weather Bureau.
Walhalla, S. C. (near)	26	P. m.			700	Thunderstorm and wind.	Two barns burned and a cow killed	Do.
Caps, Tex	28	6 p. m.	1-2 mi.		6,000	Hail	Severe damage to growing crops over path 3 to 4 miles long. Minor property damage.	Do.
Tampa, Fla	28	5.10-9 p.m.				Thunderstorm and heavy rain.	Streets flooded and traffic made impossible; city and suburban streets and roads badly washed.	Do.
Miles City, Mont	28					Wind, rain and hail.	Corn and truck gardens damaged to some extent	Do.
Electra, Tex	29	4 p. m.	1,760	2		Small tornado	Small houses and derricks blown down; little loss of crops. Path 2 miles long; 2 persons injured.	Do.
Clark County, Wis	29	do	60-1,760		6,500	Severe squall	Damage principally to silos and small farm buildings; 7 persons injured.	Official, U. S. Weather Bureau; Milwaukee Journal (Wis.).
Superior, Wis. and Duluth, Minn.	29	P. m.				Severe electrical	Many trees prostrated; grounds washed. One person injured.	Milwaukee Sentinel (Wis.).
Dallas, Tex. (north of)	30	5 p. m.				Wind and rain	Several residences damaged; 1 person injured	Dallas Morning News.
Fort Wayne, Ind	30			1		Wind	Many boats on Lake Wawasee imperiled, trees uprooted; many cottages partly wrecked.	Indianapolis Times.
Baltimore, Md., and vicinity	31			1		Thunderstorm, hail and rain.	Many telephones out of order; other property and crop damage; 5 persons injured.	Official, U. S. Weather Bureau.
Gerrardstown and Inwood sections of Berkley County, W. Va.	31					Severe hail	Damage principally to apple crop	Do.

STORMS AND WEATHER WARNINGS

WASHINGTON FORECAST DISTRICT

The disturbances that crossed the Washington forecast district during August were of slight or moderate intensity only, so that no storm warnings were required. Small-craft warnings were displayed, however, from Block Island, R. I., to Provincetown, Mass., on the 21st, and from Norfolk, Va., to Boston, Mass., on the 27th.

Frost warnings were issued for the cranberry bogs of New Jersey on the 28th.—*C. L. Mitchell.*

CHICAGO FORECAST DISTRICT

The weather of August, 1925, in this district was virtually uneventful, so far as the occurrence of conditions calling for special warnings is concerned. Only a few winds of storm force occurred on the Great Lakes, and most of these were of brief duration and in connection with thunderstorms. The only warnings issued for the benefit of shipping were those on the 28th for small craft on western Superior, and on the 8th and 22d for the same interests by the officials at Alpena, Mich., and Houghton, Mich., respectively.

Warnings for light frost were issued on the 20th and 25th for the northwestern portion of the Wisconsin cranberry marshes. The first warning was verified, while in the second instance the minimum bog temperature was 33°. Frost warnings were issued also on the 24th and 29th for areas in the northern Rocky Mountain region, and were, for the most part, verified.

Fire-weather forecasts were made during the entire month for western Montana, and similar forecasts were begun on the 28th for northeastern Minnesota, where the situation had become acute.—*C. A. Donnel.*

NEW ORLEANS FORECAST DISTRICT

In forecasting for this district in summer close attention is given to the movements and characteristics of the predominant areas of high pressure over the interior and the Atlantic coast sections of the United States. During August, 1925, the feature of principal importance in this district was the prevalence of extensive anticyclonic areas, which in extending their influence southwestward, with a rise in pressure over the Gulf States, were attended by rains along and near the Gulf coast. In successive instances unsettled weather prevailed only one or two days with this condition, until another HIGH from the west united with the extensive eastern HIGH, after which the anticyclone thus formed over the Central States moved eastward, and the southwestward thrust occurred as before.

The prevalence of conditions of this type resulted in a marked deficiency of rainfall in the interior sections of this forecast district, with temperature above normal, while along the coast the rainfall and temperature averaged nearer the normal values. Pressure gradients were generally slight and stormy weather did not develop; therefore no warnings were required.—*R. A. Dyke.*

DENVER FORECAST DISTRICT

The month was cool and showery, especially in western Colorado and southern Utah. There was only one day without showers somewhere in the district. There were two such days in Colorado, seven in New Mexico, and nine each in Arizona and Utah. No occasion arose for weather warnings of any kind.—*E. B. Gittings, jr.*

SAN FRANCISCO FORECAST DISTRICT

During August, 1925, both temperature and precipitation were about normal. There were no periods of abnormally high temperature, and the only rainfall of importance occurred in Washington and western Oregon on the 22d and 23d, when a small depression appeared over British Columbia. Frequent thunderstorms occurred in the Plateau region and the mountain regions of California.

The most important meteorological features of the month were: (*a*) The absence of "hot waves" which usually occur in August in this district, and (*b*) the reverse direction of the winds along the California coast. Usually strong northwest winds blow almost continuously during July and August, but during the past August the prevailing winds were from the south and southwest and were light in force.

In connection with the above it is well to note that the north Pacific area of high barometer was central farther west and south than usual and also that the readings near its center were much above the normal. It seldom impinged strongly on the coast and on these occasions only for short periods, after which it would again recede into the ocean without the usual secondary HIGH passing inland and causing a "hot wave."

Forest fire-weather warnings were issued in California on the 3d, 15th, and 24th, and were timely and appreciated by the forest interests. No storm warnings were issued and none were necessary.—*G. H. Willson.*

RIVERS AND FLOODS

By R. E. SPENCER

The only flood of importance during August occurred in the first week in the lower Rio Grande; report thereon will probably appear in the September number of this REVIEW. Other floods, resulting in all cases from heavy local rains and confined chiefly to the Southwest, were without material consequence aside from one railroad washout in western Colorado and some local damage at Kiowa, Colo.

Owing to the persistent drought in the Southern States rivers in that section continued, as in June and July, unusually low. At the end of August low-water records had been broken in a number of streams, the generation of hydroelectric power was considerably reduced in several States, and many localities were threatened with a serious shortage of water for direct consumption. A more comprehensive report on this subject will appear in a later issue of this REVIEW, probably that for September, 1925.

River	Station	Flood stage	Above flood stages—dates		Crest	
			From—	To—	Stage	Date
Mississippi drainage:		*Feet*			*Feet*	
Purgatoire	Higbee, Colo	4.5	5		[1] 6.0	5
Canadian	Logan, N. Mex	4	5		[1] 4.0	5
			7		[1] 5.0	7
			10	10	4.6	10
West Gulf drainage:						
Rio Grande	San Benito, Tex	21	5	5	21.4	5
Pacific drainage:						
Gila	Kelvin, Ariz	5	1		5.0	1
					6.5	6
					5.0	30

[1] Highest reading reported—probably crest.

MEAN LAKE LEVELS DURING AUGUST, 1925

By UNITED STATES LAKE SURVEY

[Detroit, Mich., Sept. 9, 1925]

The following data are reported in the "Notice to Mariners" of the above date:

Data	Lakes [1]			
	Superior	Michigan and Huron	Erie	Ontario
Mean level during August, 1925:	*Feet*	*Feet*	*Feet*	*Feet*
Above mean sea level at New York	601.49	578.42	571.08	244.90
Above or below—				
Mean stage of July, 1925	+0.10	−0.10	−0.03	−0.31
Mean stage of August, 1924	−0.09	−1.22	−1.07	−1.14
Average stage for August last 10 years	−1.04	−2.29	−1.50	−1.45
Highest recorded August stage	−2.44	−5.09	−3.03	−3.36
Lowest recorded August stage	−0.09	−1.22	−0.30	+0.55
Average departure (since 1860) of August level from July level	+0.11	−0.05	−0.19	−0.31

[1] Lake St. Clair's level: In August, 1925, 573.77 feet.

EFFECT OF WEATHER ON CROPS AND OUTDOOR OPERATIONS, AUGUST, 1925

By J. B. KINCER

General summary.—There were further beneficial rains in the Southwest during the first part of August, and crops that were not too badly damaged by the previous drought showed considerable improvement, and, at the same time, the more frequent rainfall in many other sections of the eastern half of the country was helpful. In the Central and Northern States east of the Rocky Mountains the first three weeks of the month had mostly favorable weather for growing crops, except that rain was still needed in some central-northern districts and locally in the Ohio Valley, while in the Central Plains area they came too late to be of material benefit to some crops.

In the west Gulf area scattered showers were of benefit, but it continued generally too dry, and there was very little relief in the dry sections of the Southeast, including much of Georgia, central and northern South Carolina, western North Carolina, southwestern Virginia, and eastern Tennessee. The drought in the Southeast was intensified by record-breaking temperatures and crops suffered badly. At the close of the month droughty conditions prevailed over much the greater portion of the country east of the Rocky Mountains, with rains especially needed for late gardens and truck and for the preparation of soil for fall seeding. With the prevailing warmth, crops matured rapidly, and seasonal farm operations made good progress quite generally.

Small grains.—August was generally favorable for the harvesting of wheat and other small grains in the late districts, and for threshing in the principal Wheat Belt. At the close of the month harvest had been completed, except in the more elevated districts of the Rocky Mountains. Plowing for winter wheat advanced favorably until near the end of the month when the soil became too dry in most sections of the Wheat Belt. Some wheat was seeded in northwestern Kansas and in Iowa. Buckwheat grew well under weather favorable for that crop and rice developed satisfactorily in California and continued in very good condition in Texas.

Corn.—Conditions were mostly favorable for corn from the central and upper Mississippi Valley eastward, but it was unfavorable in much of the Great Plains and in the South. Early in the period beneficial rains occurred in the upper Mississippi Valley, and moisture was mostly sufficient in the Ohio Valley States and middle Atlantic area, while temperature conditions were favorable for growth. Exceptionally good growing weather prevailed in the last-named section and corn made good to excellent progress. Showers were helpful in the middle Plains, but the rain came too late to be of very great benefit in parts of the area. In the South late corn was unfavorably affected by lack of moisture during most of the month. The latter part was dry and warm, with excessive sunshine, over the principal Corn Belt and the crop made rapid progress toward maturity. In fact, premature ripening, with rather unfavorable effects, was reported from some sections.

Cotton.—In the western Cotton Belt good rains the latter part of the preceding month and early in August largely relieved droughty conditions, while in central and eastern districts showers were beneficial in many places. Thereafter, it again became too dry in the West, and at the close of the month rain was badly needed in Oklahoma, but at the same time, in Texas, cooler weather and showers checked shedding and premature opening. In the eastern portion of the belt, moisture was insufficient in most districts, and considerable deterioration to cotton occurred, with extensive premature opening and shedding, particularly in northern Georgia, much of South Carolina, and in the western cotton districts of North Carolina. The weather was favorable for rapid maturity in nearly all parts of the belt and, in general at the close of the month the crop was much in advance of an average year. Picking and ginning made good progress in southern districts.

Miscellaneous crops.—Pastures and meadows had insufficient moisture from the Ohio River southward and also in central-northern districts, but conditions continued generally favorable in the great western grazing sections. Potatoes were favorably affected by the weather in the central Rocky Mountain area and from the upper Ohio Valley and Lake region eastward, but it was too dry in some other sections. Sugar beets made good progress in most States where they are grown and cane did well in the extreme lower Mississippi Valley.

CLIMATOLOGICAL TABLES[1]

CONDENSED CLIMATOLOGICAL SUMMARY

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

Condensed climatological summary of temperature and precipitation by sections, August, 1925

Station	Temperature								Precipitation					
			Monthly extremes								Greatest monthly		Least monthly	
	Section average	Departure from the normal	Station	Highest	Date	Station	Lowest	Date	Section average	Departure from the normal	Station	Amount	Station	Amount
	°F.	°F.		°F.			°F.		In.	In.		In.		In.
Alabama	80.9	+1.1	2 stations	107	20	Talladega	51	1	1.55	−3.17	Mentone	4.39	2 stations	0.00
Alaska [*July*]	55.2	−0.5	Eagle	95	25	2 stations	30	[2] 2	3.58	+0.69	Ketchikan	12.81	Rampart	0.65
Arizona	77.7	−1.4	3 stations	113	[2] 4	Bright Angel Ranger Station.	27	15	2.28	−0.18	Santa Marguerita	6.98	Mohawk	0.00
Arkansas	80.3	+0.9	2 stations	108	[2] 19	Dutton	47	1	1.81	−2.02	Marshall	7.14	2 stations	0.00
California	70.3	−1.4	Greenland Ranch	120	5	Gem Lake	18	24	0.22	+0.13	Lake Sebrina	2.68	87 stations	0.00
Colorado	63.5	−1.3	Holly	104	17	2 stations	25	[2] 15	2.65	+0.73	Meeker	6.47	Las Animas	0.13
Florida	81.5	+0.1	Bonifay	104	19	4 stations	61	[2] 19	6.99	+0.03	Chapman Field Garden.	17.56	Mount Pleasant	1.71
Georgia	80.6	+1.1	2 stations	110	20	Blue Ridge	45	[2] 25	1.79	−3.73	St. George	10.63	Clayton	0.00
Hawaii	75.1	+0.3	Pahala	94	3	Waimea	50	24	7.61	+0.36	Puohakamoa	34.40	5 stations	0.00
Idaho	64.9	−1.4	Kooskia	106	2	Bostetter	21	24	1.02	+0.38	Driggs	5.21	Mountainhome	T.
Illinois	74.6	+0.5	8 stations	104	19	Waukegan	45	22	2.54	−0.78	Beardstown	5.96	Grand Chain	0.29
Indiana	73.6	+0.3	Rome	103	19	Howe	37	27	2.50	−0.76	Madison	6.83	Hobart	0.31
Iowa	72.4	+0.7	Afton	99	18	Le M[illegible]	39	21	3.47	+0.03	Guthrie Center	8.36	Alton	0.31
Kansas	77.2	+0.1	3 stations	107	18	2 stations	41	1	3.18	+0.33	Wakeney	8.62	Pleasanton	0.35
Kentucky	76.4	+0.8	Earlington	106	19	Farmers	44	26	1.47	−2.24	Carrollton	5.17	Marion	T.
Louisiana	82.0	+0.4	3 stations	106	20	Tallulah	56	[2] 24	3.25	−1.98	Burrwood	15.70	Calhoun	0.14
Maryland-Delaware	71.7	−1.6	Frederick, Md	98	31	2 stations	35	22	2.50	−1.84	Easton, Md	6.13	Dover, Del	0.86
Michigan	68.3	+2.0	Monroe	101	30	Sidnaw	26	27	2.28	−0.51	Harrison	5.43	Mackinac Island	0.08
Minnesota	69.5	+2.8	Milan	102	23	Pine River Dam	29	21	2.09	−1.11	Two Harbors	5.87	Farmington	T.
Mississippi	81.1	+0.6	3 stations	106	[2] 20	Batesville	53	22	2.27	−2.02	Bay St. Louis	8.37	2 stations	0.85
Missouri	76.5	+0.5	Lamonte	107	18	Seymour	45	1	3.45	−0.23	Maryville	11.24	Cape Girardeau	0.68
Montana	64.5	−0.2	2 stations	103	22	Babb	22	31	0.89	−0.27	Carter	2.85	2 stations	0.00
Nebraska	73.0	+0.2	Alma	104	18	2 stations	38	1	3.46	+0.65	Tecumseh	8.93	Harrison	0.40
Nevada	68.2	−2.7	Logandale	112	21	Quinn River Ranch	21	[2] 24	0.86	+0.45	Sharp	1.84	Quinn River Ranch	0.08
New England	66.8	+0.1	2 stations	95	[2] 10	Somerset, Vt	26	21	2.11	−1.72	Bridgeport, Conn	5.70	Madison, Me	0.35
New Jersey	71.0	−0.9	9 stations	93	[2] 20	2 stations	35	28	2.10	−2.71	Belleplain	4.12	Belvidere	0.94
New Mexico	68.3	−1.8	Lakewood	102	23	3 stations	32	[2] 13	2.99	+0.51	Carson Seep Ranger Station.	9.11	Albuquerque	0.49
New York	67.6	+0.3	Ohioville	96	31	do	29	28	2.57	−1.29	Taberg	5.45	Chazy	0.64
North Carolina	74.9	−0.3	Rockingham	107	20	Parker	36	26	2.75	−2.63	Swansboro	7.03	Asheville	0.22
North Dakota	67.9	+2.5	Linton	110	5	Carson	29	25	1.07	−1.21	Pembina	3.40	Arnegard	0.05
Ohio	72.0	+0.3	Fremont	101	30	3 stations	40	[2] 22	2.34	−1.12	Wilmington	7.28	Warren	0.75
Oklahoma	80.8	+0.0	Okeene	109	18	4 stations	50	[2] 1	1.65	−1.66	Wichita National Forest.	5.30	Hennessey	0.13
Oregon	65.0	−1.2	Echo	106	1	Fremont	14	24	0.74	+0.18	La Grande	2.97	2 stations	0.00
Pennsylvania	69.7	−0.7	Brookville	97	31	West Bingham	26	28	2.28	−2.24	Bradford	5.14	Sharon	0.65
Porto Rico	79.5	+0.4	2 stations	97	[2] 19	Mayaguez	56	3	4.69	−2.50	Coloso	11.50	Santa Rita	0.00
South Carolina	80.2	+1.3	4 stations	109	[2] 13	Heath Springs	53	23	1.48	−4.40	Santuck	3.31	Society Hill	0.28
South Dakota	73.0	+3.3	Academy	108	23	5 stations	38	[2] 13	1.31	−1.01	Wentworth	3.64	Belvidere	0.21
Tennessee	77.4	+1.0	Perryville	107	19	Crossville	42	26	1.53	−2.63	Kenton	5.06	Carthage	T.
Texas	82.7	+0.0	3 stations	112	[2] 13	2 stations	49	[2] 3	2.18	−0.38	Spur	7.37	Mount Pleasant	0.05
Utah	67.8	−1.6	St. George	103	1	Woodruff	30	18	1.71	+0.62	Monticello	4.99	Black Rock	T.
Virginia	72.7	−1.6	Danville	101	[2] 13	Burkes Garden	35	26	2.47	−2.12	Callaville	6.26	Staunton	0.21
Washington	65.3	−0.5	5 stations	106	20	Deer Park	27	29	0.70	−0.16	Cedar Lake	4.46	5 stations	0.00
West Virginia	70.7	−0.9	2 stations	100	[2] 10	2 stations	33	[2] 22	1.86	−2.14	Bayard	4.92	Camden-on-Gauley	0.20
Wisconsin	68.7	+1.7	2 stations	98	[2] 17	Long Lake	31	21	2.30	−1.04	Brule Island	6.01	River Falls	0.06
Wyoming	63.2	−0.9	4 stations	99	22	Riverside	17	25	1.32	+0.32	Alta	3.90	Sheridan	T.

[1] For description of tables and charts, see REVIEW, January, 1925, p. 42.

[2] Other dates also.

TABLE 1.—*Climatological data for Weather Bureau stations, August, 1925*

Districts and stations	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles								0-10	In.	In.
New England							67.7	+0.3										77	1.84	−2.0										4.0		
Eastport	76	67	85	29.92	30.00	+.04	60.7	0.0	85	26	70	45	28	52	31	57	56	86	1.92	−1.3	12	4,324	s.	26	nw.	11	8	10	13	6.3	0.0	0.0
Greenville, Me.	1,070	6		28.88	30.04		63.5		85	17	74	38	29	53	33				1.27		13	3,405	nw.	22		12	11	7	13		0.0	0.0
Portland, Me.	103	82	117	29.93	30.05	+.07	67.6	+1.2	89	26	77	47	28	58	31	60	56	72	0.55	−3.0	8	5,175	nw.	28	nw.	20	16	6	9	4.5	0.0	0.0
Concord	288	70	79	29.73	30.04	+.06	66.6	−0.2	91	18	80	38	29	53	40				1.48	−2.3	11	1,792	nw.	17	n.	28	21	4	6	3.2	0.0	0.0
Burlington	404	11	48	29.61	30.04	+.07	66.6	−1.3	86	17	77	39	28	56	32				1.27	−2.7	7	5,440	s.	26	s.	31	11	13	7	4.7	0.0	0.0
Northfield	876	12	60	29.14	30.08	+.10	62.6	−0.8	86	30	76	32	28	50	43	55	56	86	2.02	−1.9	10	3,474	s.	24	n.	7	11	10	10	5.5	0.0	0.0
Boston	125	115	188	29.91	30.04	+.05	71.2	+1.3	92	26	80	50	28	62	26	63	58	67	1.40	−2.6	7	5,599	sw.	26	w.	20	19	6	6	3.6	0.0	0.0
Nantucket	12	14	90	30.04	30.04	+.05	68.4	+0.6	81	20	75	55	23	62	20	64	62	84	2.49	−0.6	7	9,606	sw.	39	ne.	27	20	5	6	3.7	0.0	0.0
Block Island	26	11	46	30.03	30.06	+.07	69.0	+0.5	82	20	75	53	28	63	16	64	62	84	2.28	−1.2	7	9,184	sw.	38	e.	1	21	4	6	3.3	0.0	0.0
Providence	160	215	251	29.88	30.05	+.06	70.6	−0.4	89	26	81	49	28	61	26	62	58	67	1.88	−2.2	9	6,549	w.	34	w.	11	20	5	6	3.6	0.0	0.0
Hartford	159	122	140	29.89	30.06	+.07	70.7	+1.8	90	18	81	46	28	60	32				2.32	−2.2	7		s.				22	3	6	3.0	0.0	0.0
New Haven	106	74	153	29.95	30.06	+.07	70.9	+0.6	91	26	80	49	28	62	28	64	60	72	2.68	−2.3	9	5,035	sw.	31	sw.	9	22	4	5	2.8	0.0	0.0
Middle Atlantic States							72.3	−0.9										74	2.32	−2.2										4.3		
Albany	97	102	115	29.95	30.05	+.07	70.6	−0.2	91	10	81	44	28	60	32	63	59	73	1.77	−2.2	9	3,811	s.	29	ne.	27	22	5	4	3.3	0.0	0.0
Binghamton	871	10	84	29.17	30.08	+.09	68.2	+0.2	88	10	80	40	28	56	37				2.06	−1.3	10	2,878	w.	17	w.	10	12	10	9	5.3	0.0	0.0
New York	314	414	454	29.74	30.07	+.07	71.9	−1.2	89	26	80	54	22	64	25	64	60	72	1.64	−2.9	7	9,113	s.	40	nw.	20	12	11	8	5.0	0.0	0.0
Harrisburg	374	94	104	29.70	30.09	+.08	72.0	−0.6	91	31	82	51	28	62	27	64	60	70	4.22	0.0	6	3,568	ne.	33	n.	8	11	12	8	4.9	0.0	0.0
Philadelphia	114	123	190	29.96	30.08	+.08	74.8	0.0	92	26	83	54	28	66	26	67	63	71	2.01	−2.6	7	5,365	sw.	25	ne.	27	15	10	6	4.0	0.0	0.0
Reading	325	81	98	29.73	30.08		72.2		92	31	83	51	29	62	29	65	62	73	1.86	−2.6	7	3,037	sw.	19	w.	1	18	8	5	3.8	0.0	0.0
Scranton	805	111	119	29.24	30.09	+.09	69.0	−0.8	89	26	80	45	22	58	34	63	61	81	1.35	−2.9	10	3,320	n.	26	nw.	14	12	12	7	4.6	0.0	0.0
Atlantic City	52	37	172	30.02	30.07	+.07	71.9	−0.6	90	14	78	53	22	65	20	66	63	76	2.88	−1.4	6	9,480	w.	40	ne.	27	17	10	4	3.3	0.0	0.0
Cape May	17	13	49	30.09	30.11	+.11	72.5	−0.9	91	10	80	52	28	64	22	67	64	80	3.38	−0.9	7	3,859	sw.	16	ne.	27	15	10	6	4.3	0.0	0.0
Sandy Hook	22	10	55	30.04	30.06		72.8		90	26	80	57	28	66	24	65	61	74	1.19		7	8,510	sw.	38	sw.	11	15	10	6	3.7	0.0	0.0
Trenton	190	159	183	29.87	30.07		72.2		90	26	82	51	28	62	28	65	62	74	1.15	−4.2	7	5,692	sw.	27	n.	27	13	10	8	4.5	0.0	0.0
Baltimore	123	100	113	29.95	30.07	+.06	74.7	−0.8	93	10	84	56	22	66	26	67	64	70	2.41	−1.8	8	3,476	sw.	16	n.	21	17	10	4	3.7	0.0	0.0
Washington	112	62	85	29.97	30.08	+.07	73.0	−2.0	92	10	83	52	23	63	30	66	62	74	3.89	−0.5	10	3,200	n.	30	nw.	13	12	14	5	4.8	0.0	0.0
Cape Henry	18	8	54	30.04	30.06		75.1		93	13	81	63	30	69	24	70	67	79	5.36	−0.7	8	9,105	ne.	50	nw.	10	13	14	4	4.3	0.0	0.0
Lynchburg	681	153	188	29.36	30.10	+.08	74.0	−1.6	95	10	86	49	23	62	37	65	61	72	0.56	−3.7	6	3,644	n.	39	n.	31	15	11	5	4.3	0.0	0.0
Norfolk	91	170	205	29.99	30.08	+.08	76.2	−1.2	96	14	84	64	31	69	24	68	65	74	1.05	−4.9	10	8,056	ne.	42	s.	11	11	15	5	4.7	0.0	0.0
Richmond	144	11	52	29.94	30.09	+.08	74.3	−2.2	94	20	84	53	23	64	32	67	64	74	2.55	−1.9	11	4,644	e.	22	nw.	31	15	12	4	3.6	0.0	0.0
Wytheville	2,304	49	55	27.77	30.09	+.08	69.4	−1.1	93	10	82	46	24	57	36	61	57	70	1.32	−3.2	6	3,216	nw.	20	sw.	13	11	13	7	4.9	0.0	0.0
South Atlantic States							78.7	+0.6										72	3.12	−3.0										4.5		
Asheville	2,255	70	84	27.80	30.08	+.06	72.0	−1.5	96	20	83	50	25	61	35	62	57	67	0.22	−4.4	3	4,480	se.	26	n.	31	9	19	3	4.3	0.0	0.0
Charlotte	779	55	62	29.26	30.07	+.05	78.2	+1.1	103	20	89	56	23	67	30	67	62	63	3.34	−2.2	6	2,944	ne.	17	n.	21	16	10	5	4.1	0.0	0.0
Hatteras	11	11	50	30.03	30.04	+.04	78.0	0.0	90	14	83	67	31	73	18	72	70	79	3.81	−2.0	9	9,497	ne.	62	w.	14	13	12	6	4.5	0.0	0.0
Raleigh	376	103	110	29.68	30.07	+.06	76.0	−1.0	98	20	86	56	23	66	30	68	64	74	3.42	−2.5	8	5,099	ne.	57	nw.	14	12	13	6	4.4	0.0	0.0
Wilmington	78	81	91	29.98	30.06	+.06	78.2	+0.6	101	14	87	62	23	69	25	72	69	80	4.65	−1.9	9	5,099	sw.	34	sw.	10	10	16	5	4.9	0.0	0.0
Charleston	48	11	92	30.00	30.05	+.04	81.2	+0.2	102	14	88	66	23	74	27	74	72	80	1.62	−5.4	5	8,615	ne.	36	ne.	23	12	8	11	5.3	0.0	0.0
Columbia, S. C.	351	41	57	29.69	30.07	+.06	80.8	+1.2	104	13	92	60	23	70	31	69	64	63	0.94	−5.8	6	4,975	ne.	22	n.	6	16	12	3	3.8	0.0	0.0
Due West	711	10	55	29.34	30.10		79.5		105	20	91	58	23	68	35				0.97		2	5,668	ne.	28	n.	21	18	11	2	3.4	0.0	0.0
Greenville, S. C.	1,039	113	122	28.99	30.06		78.7	+2.9	101	20	89	59	23	68	32	66	60	60	0.78		5	4,238	e.	44	w.	20	18	11	2	3.6	0.0	0.0
Augusta	182	62	77	29.85	30.04	+.03	82.0	+1.6	105	20	93	62	23	71	32	70	66	62	0.49	−5.1	5	4,104	ne.	31	nw.	21	14	12	5	4.4	0.0	0.0
Savannah	65	150	194	29.98	30.05	+.04	80.4	−0.3	102	14	89	66	23	72	30	73	71	81	7.09	−0.4	11	7,896	ne.	78	nw.	21	14	9	8	4.7	0.0	0.0
Jacksonville	43	209	245	29.99	30.04	+.03	80.2	−1.5	95	20	87	69	27	74	25	74	72	83	5.63	−0.6	13	8,211	ne.	50	nw.	14	8	10	13	6.1	0.0	0.0
Florida Peninsula							82.8	+0.4										78	8.51	+1.9										5.9		
Key West	22	10	64	29.97	29.99	+.01	84.0	+0.5	93	1	90	72	31	78	17	77	75	75	3.57	−1.1	15	4,792	se.	22	e.	31	10	13	8	5.5	0.0	0.0
Miami	25	71	79	29.99	30.02		82.1	+0.1	91	14	88	72	5	76	17	76	74	78	8.95	+2.5	18	3,294	e.	17	e.	29	2	18	11	6.6	0.0	0.0
Tampa	35	79	87	29.98	30.01	+.01	82.2	+0.7	94	3	90	69	28	74	22	74	72	80	13.01	+4.4	14	3,587	ne.	28	se.	29	2	23	6	5.9	0.0	0.0
Titusville	44	5		29.74	30.02		81.4		100	21	89	68	28	74	25				3.74		11		sw.				6	16	9	5.6	0.0	0.0
East Gulf States							80.9	+1.1										69	1.54	−3.3										4.5		
Atlanta	1,174	190	216	28.86	30.07	+.06	79.8	+2.8	100	20	89	62	1	70	25	66	59	56	0.02	−4.5	2	6,496	e.	58	nw.	14	16	4	11	4.8	0.0	0.0
Macon	370	78	87	29.66	30.05	+.04	81.1	+1.2	105	20	92	62	2	71	30	69	63	60	0.70	−3.5	3	3,998	ne.	22	nw.	21	15	9	7	4.2	0.0	0.0
Thomasville	273	49	58	29.75	30.04	+.04	80.9	−0.1	98	20	91	65	27	71	28	72	69	76	3.44	−1.6	14	3,288	ne.	20	e.	30	7	6	18	6.6	0.0	0.0
Apalachicola	36	42	49	29.99	30.03		80.4		94	10	87	70	23	74	20	75	73	80	12.19		15	5,989	ne.	31	n.	21	14	9	8	4.6	0.0	0.0
Pensacola	56	149	185	29.98	30.04	+.06	80.7	−0.2	97	20	87	67	23	74	22	74	71	76	2.90	−4.3	11	8,882	w.	44	e.	22	11	12	8	5.2	0.0	0.0
Anniston	741	9	57	29.31	30.10	+.11	78.4	+2.1	101	19	91	56	27	66	41				0.58	−3.9	2	2,793	se.	33	nw.	14	20	10	1	3.0	0.0	0.0
Birmingham	700	11	48	29.34	30.09	+.10	81.0	+1.8	102	19	93	59	1	69	35	68	62	60	0.71	−3.8	5	3,698	e.	32	nw.	14	19	11	1	3.1	0.0	0.0
Mobile	57	125	161	29.98	30.04	+.06	82.4	+1.4	99	20	91	68	2	74	24	73	71	76	1.27	−5.5	8	6,038	sw.	40	w.	21	7	16	8	5.1	0.0	0.0
Montgomery	223	100	112	29.81	30.05	+.06	82.0	+1.2	101	19	92	63	26	72	31	70	64	62	0.44	−3.8	4	4,241	e.	25	n.	9	12	11	8	4.7	0.0	0.0
Corinth	460	6					80.0		101	28	93	58	1	67	40				2.82		6		ne				9	22	0		0.0	0.0
Meridian	375	85	93	29.66	30.04	+.06	79.8	+0.3	99	19	91	60	27	69	37	70	66	69	1.25	−2.3	5	3,147	e.	23	e.	29	18	10	3	3.6	0.0	0.0
Vicksburg	247	65	73	29.78	30.06	+.08	82.0	+1.2	101	20	92	63	24	72	27	70	66	65	1.26	−2.3	3	3,842	e.	34	nw.	14	15	10	6	4.1	0.0	0.0
New Orleans	53	76	84	29.98	30.03	+.05	82.6	+0.4	100	20	90	69	30	75	25	74	72	77	4.41	−1.2	12	4,228	e.	23	e.	23	9	16	6	5.2	0.0	0.0
West Gulf States							82.8	+1.0										68	1.41	−1.6										3.5		
Shreveport	249	77	93	29.76	30.02	+.05	84.0	+2.0	103	20	94	63	2	74	26	71	66	62	0.23	−2.0	4	4,354	e.	24	e.	25	24	5	2	2.6	0.0	0.0
Bentonville	1,303	11	44				77.3	+0.8	98	20	90	54	1	65	32				4.80		7	2,744	s.	30	sw.	20	22	9	0		0.0	0.0
Fort Smith	457	79	94	29.54	30.01	+.04	82.0	+1.5	103	20	94	60	1	70	31	70	65	64	0.76	−2.9	5	4,814	e.	38	w.	10	23	5	3	2.9	0.0	0.0
Little Rock	357	136	144	29.66	30.03	+.05	81.1	+1.3	100	20	92	62	1	70	31	69	63	60	0.94	−2.7	6	3,909	s.	30	nw.	15	23	7	1	2.2	0.0	0.0
Brownsville	57	53	61	29.90	29.96		84.2	+0.3	95	17	93	71	25	76	20	75	73	79	1.96		8	4,833	s.	20	s.	15	18	11	2	3.7	0.0	0.0
Corpus Christi	20	11	73	29.98	30.00	+.07	83.1	+0.6	94	13	89	70	3	78	17	76	74	80	2.25	0.0	8	8,641	se.	32	se.	9	20	7	4	3.1	0.0	0.0
Dallas	512	109	117	29.48	30.01		84.9		104	20	94	65	2	75	25				1.20		4	4,795	s.	31	nw.	22	18	9	4	3.5	0.0	0.0
Fort Worth	670	106	114	29.28	29.98	+.04	84.8	+1.8	106	20	95	63	2	75	28	70	63	55	0.40	−2.3	2	6,103	s.	22	se.	23	17	13	1	3.9	0.0	0.0
Galveston	54	106	114	29.97	30.03	+.07	82.1	−0.9	95	20	87	69	22	78	19	76	74	79	2.78	−2.2	9	6,966	s.	38	e.	22	19	10	2	3.3	0.0	0.0
Groesbeck	461	11	56	29.54	30.00		84.2		103	17	95	62	1	73	29				1.16		5	5,888	s.	55	se.	23	13	15	3	4.0	0.0	0.0
Houston	138	111	121	29.88	30.02		83.9	+0.7	102	16	94	68	30	74	31				3.95		4	4,633	s.	28	se.	23	20	10	1	3.5	0.0	0.0
Palestine	510	64	72	29.48	30.00	+.03	83.6	+1.8	103	20	94	62	1	73	27	70	65	62	1.85	−0.4	6	3,536	s.	18	ne.	31	10	19	2	4.5	0.0	0.0
Port Arthur	34	58	66	29.97	30.01		82.9		99	20	91	69	2	75	23	75	72	78	2.53		8	5,976	s.	26	ne.	22	18	9	4	3.5	0.0	0.0
San Antonio	693	119	132	29.28	29.98	+.05	84.0	+0.5	102	13	95	63	2	73	32	71	67	65	1.72	−1.0	6	4,958	s.	31	ne.	23	15	11	5	4.0	0.0	0.0
Taylor	583	55	63	29.44	30.05	+.10	83.8	+2.1	102	21	95	61	1	73	30				1.72	−0.8	10	5,674	s.	34	e.	31	11	17	3	4.3	0.0	0.0

TABLE 1.—*Climatological data for Weather Bureau stations, August, 1925*—Continued

Districts and stations	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature: Mean max. + mean min. ÷ 2	Temperature: Departure from normal	Temperature: Maximum	Temperature: Date	Temperature: Mean maximum	Temperature: Minimum	Temperature: Date	Temperature: Mean minimum	Temperature: Greatest daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles								0–10	In.	In.
Ohio Valley and Tennessee							**75.8**	**+0.8**										**66**	**1.83**	**−1.6**										**3.8**		
Chattanooga	762	189	213	29.26	30.06	+.06	79.2	+1.7	99	20	91	60	26	68	31	66	60	59	1.28	−2.5	7	4,687	w.	27	nw.	18	16	13	2	3.7	0.0	0.0
Knoxville	996	102	111	29.03	30.06	+.05	78.4	+2.2	100	13	90	58	2	66	31	66	60	59	1.63	−2.4	6	3,584	ne.	30	s.	20	21	7	3	3.2	0.0	0.0
Memphis	399	76	97	29.63	30.04	+.06	81.4	+2.0	100	19	91	61	1	72	28	70	65	63	3.20	0.0	6	3,668	e.	54	nw.	11	21	8	2	2.4	0.0	0.0
Nashville	546	168	191	29.50	30.07	+.07	79.4	+1.6	102	19	91	59	1	67	33	66	60	58	1.02	−2.4	5	4,569	ne.	38	w.	13	20	10	1	2.9	0.0	0.0
Lexington	989	193	230	29.04	30.08	+.07	76.2	+1.7	95	17	86	54	1	66	25	----	----	----	1.15	−2.4	7	7,739	ne.	38	sw.	2	15	14	2	3.5	0.0	0.0
Louisville	525	188	234	29.50	30.08	+.08	77.8	+0.8	99	19	89	58	1	67	31	67	62	65	0.89	−2.6	5	5,484	ne.	66	nw.	19	18	11	2	3.2	0.0	0.0
Evansville	431	139	175	29.60	30.06	+.07	79.4	+2.0	102	19	91	58	1	68	30	67	61	59	0.48	−2.8	3	5,437	sw.	36	sw.	12	13	17	1	3.7	0.0	0.0
Indianapolis	822	194	230	29.20	30.07	+.07	74.3	+0.6	93	29	84	55	28	64	33	65	61	68	3.82	+0.5	11	6,115	se.	46	nw.	19	12	14	5	4.2	0.0	0.0
Royal Center	736	11	55	29.29	30.07	------	71.4	------	94	30	84	50	1	59	38	----	----	----	0.55	------	5	4,551	se.	25	sw.	17	11	13	7	4.6	0.0	0.0
Terre Haute	575	96	129	29.45	30.06	------	75.2	------	94	29	86	57	1	65	30	66	61	68	4.42	------	7	4,466	e.	48	w.	12	9	16	6	4.7	0.0	0.0
Cincinnati	627	11	51	29.41	30.07	+.06	74.0	+0.4	93	19	85	54	22	63	32	----	63	70	3.45	+0.1	9	3,489	ne.	29	nw.	12	19	9	3	3.2	0.0	0.0
Columbus	822	179	222	29.22	30.08	+.07	73.5	+0.5	92	30	84	55	22	64	29	65	61	70	2.37	−0.8	7	5,349	w.	40	nw.	12	18	4	9	4.2	0.0	0.0
Dayton	899	137	173	29.13	30.06	------	73.4	0.0	91	17	84	52	23	62	33	65	61	71	2.49	−0.5	9	4,374	ne.	38	ne.	5	17	12	2	3.4	0.0	0.0
Elkins	1,947	59	67	28.10	30.11	+.09	67.7	−1.4	88	30	80	42	24	55	40	61	59	83	1.18	−2.5	7	2,310	w.	27	nw.	31	13	11	7	5.1	0.0	0.0
Parkersburg	637	77	82	29.45	30.10	+.09	74.2	+0.3	95	30	86	52	22	63	36	64	60	69	1.65	−1.9	10	2,585	n.	33	nw.	31	17	3	11	4.7	0.0	0.0
Pittsburgh	842	353	410	29.19	30.08	+.07	72.3	−0.6	92	30	82	50	22	62	31	63	59	68	0.96	−2.2	5	5,733	se.	56	nw.	10	11	12	8	4.7	0.0	0.0
Lower Lake Region							**70.3**	**+0.5**										**70**	**1.77**	**−1.2**										**4.0**		
Buffalo	767	247	280	29.26	30.08	+.09	69.4	−0.4	89	17	76	47	28	62	25	63	60	75	2.48	−0.5	10	7,751	sw.	35	w.	19	15	9	7	4.5	0.0	0.0
Canton	448	10	61	29.56	30.02	------	67.0	−0.8	89	18	78	39	28	56	35	----	----	----	1.74	−1.0	8	4,900	w.	29	e.	5	24	4	3	2.4	0.0	0.0
Oswego	335	76	91	------	30.06	+.07	68.0	−0.4	88	18	76	47	28	60	32	----	----	----	0.73	−2.0	6	------	s.	24	nw.	20	15	10	6	----	0.0	0.0
Rochester	523	86	102	29.52	30.08	+.09	70.2	+1.0	92	17	80	47	28	61	31	62	57	68	1.12	−1.8	9	4,503	sw.	21	w.	10	16	9	6	4.1	0.0	0.0
Syracuse	597	97	113	29.45	30.09	+.10	68.6	0.0	88	17	78	45	28	60	27	----	----	----	2.00	−1.3	9	5,416	s.	25	w.	11	14	11	6	4.7	0.0	0.0
Erie	714	130	166	29.31	30.07	+.06	70.4	+0.8	90	30	78	51	22	62	24	64	60	69	2.41	−0.8	7	7,522	s.	31	ne.	27	14	10	7	4.1	0.0	0.0
Cleveland	762	190	201	29.27	30.08	+.07	70.9	+0.9	92	30	79	52	22	63	25	64	59	69	1.42	−1.7	9	7,253	s.	40	n.	1	13	12	6	4.5	0.0	0.0
Sandusky	629	62	70	29.41	30.08	+.07	71.9	+0.1	96	30	80	54	22	64	28	----	----	----	0.96	−2.4	7	4,852	e.	37	n.	21	12	12	7	4.4	0.0	0.0
Toledo	628	208	243	29.41	30.08	+.08	72.5	+1.2	96	30	82	51	27	63	29	64	60	70	2.05	−0.6	10	6,817	e.	30	sw.	8	20	7	4	3.1	0.0	0.0
Fort Wayne	856	113	124	29.17	30.08	------	72.5	+1.4	94	30	84	52	27	61	36	63	59	67	1.10	------	8	4,096	sw.	23	nw.	20	15	11	5	3.7	0.0	0.0
Detroit	730	218	258	29.31	30.09	+.08	72.1	+1.8	94	30	81	52	27	63	27	63	58	67	2.81	0.0	13	5,101	e.	31	nw.	7	13	12	6	4.0	0.0	0.0
Upper Lake Region							**68.8**	**+2.3**										**74**	**1.86**	**−1.1**										**4.1**		
Alpena	609	13	92	29.43	30.09	+.09	67.0	+2.9	96	30	77	44	28	57	37	61	57	72	0.51	−2.8	5	6,210	se.	40	w.	30	9	18	4	4.7	0.0	0.0
Escanaba	612	54	60	29.41	30.06	+.07	66.2	+1.9	88	25	75	43	21	58	26	61	58	78	1.14	−2.5	9	6,132	s.	28	n.	26	13	16	2	4.4	0.0	0.0
Grand Haven	632	54	89	29.39	30.06	+.07	68.2	+1.1	85	29	77	50	22	59	31	62	59	74	1.71	−0.9	10	5,268	w.	24	w.	10	17	10	4	3.5	0.0	0.0
Grand Rapids	707	70	87	29.32	30.08	+.08	71.6	+1.9	92	30	82	51	27	61	32	63	58	67	2.56	0.0	9	2,902	nw.	17	nw.	10	11	14	6	4.5	0.0	0.0
Houghton	668	62	99	29.31	30.03	+.06	67.2	+3.5	92	24	77	46	21	58	30	----	----	----	2.15	−0.7	8	5,976	e.	35	w.	9	10	18	3	4.3	0.0	0.0
Lansing	878	11	62	29.15	30.08	------	69.6	+1.1	96	30	82	47	28	57	39	62	60	80	2.15	−0.5	10	2,387	nw.	15	n.	5	15	12	4	3.7	0.0	0.0
Ludington	637	60	66	29.39	30.08	------	66.6	------	83	29	74	47	27	59	25	61	58	76	3.00	------	6	5,306	s.	25	s.	30	22	7	2	2.5	0.0	0.0
Marquette	734	77	111	29.27	30.07	+.09	67.8	+4.0	90	17	77	45	26	58	26	60	56	70	1.96	−0.9	9	7,114	s.	38	sw.	29	7	14	10	5.9	0.0	0.0
Port Huron	638	70	120	29.39	30.08	+.08	69.2	+1.4	93	30	79	48	22	59	35	62	58	72	1.60	−1.0	5	5,835	s.	34	ne.	1	18	8	5	3.5	0.0	0.0
Saginaw	641	------	------	29.40	30.09	------	70.3	+1.6	98	30	83	48	22	57	42	----	----	----	4.89	------	9	------	nw.	------	------	------	------	------	------	------	0.0	0.0
Sault Sainte Marie	614	11	52	29.39	30.08	+.09	66.0	+3.9	89	17	78	44	22	54	35	59	55	77	0.75	−2.4	5	4,199	nw.	29	nw.	30	13	17	1	4.2	0.0	0.0
Chicago	823	140	310	29.19	30.07	+.07	73.6	+0.8	96	30	80	57	21	68	22	65	61	69	2.09	−0.8	6	5,739	e.	24	n.	26	18	7	6	3.5	0.0	0.0
Green Bay	617	109	141	29.40	30.06	+.07	69.2	+1.5	90	29	79	46	21	59	27	62	58	74	2.61	−0.5	7	6,147	s.	29	ne.	26	10	16	5	4.6	0.0	0.0
Milwaukee	681	125	139	29.34	30.08	+.08	70.5	+1.3	91	30	78	50	21	64	22	63	60	72	1.85	−1.0	7	5,754	se.	27	se.	12	16	9	6	4.2	0.0	0.0
Duluth	1,133	5	47	28.82	30.02	+.05	67.5	+4.9	91	24	78	46	21	57	27	62	60	84	3.04	−0.5	10	7,756	ne.	47	nw.	18	16	11	4	3.8	0.0	0.0
North Dakota							**68.9**	**+2.7**										**61**	**0.89**	**−1.4**										**3.0**		
Moorhead	940	50	58	28.95	29.94	−.02	70.7	+4.6	99	23	84	43	21	57	42	62	57	66	0.25	−2.8	7	5,654	s.	30	sw.	28	22	8	1	3.0	0.0	0.0
Bismarck	1,674	8	57	28.22	29.98	+.04	69.6	+2.3	100	22	84	45	25	53	46	58	50	56	1.69	−0.3	9	5,966	nw.	34	n.	29	25	5	1	2.0	0.0	0.0
Devils Lake	1,478	11	44	28.39	29.94	.00	67.8	+2.7	103	23	82	40	20	53	42	58	53	69	0.89	−1.9	6	6,069	se.	30	ne.	21	17	8	6	4.0	0.0	0.0
Ellendale	1,457	10	56	28.44	29.98	------	70.2	------	103	23	86	43	21	55	44	----	----	----	1.45	------	7	8,915	s.	48	sw.	17	17	10	4	3.5	0.0	0.0
Grand Forks	835	12	89	------	------	------	68.2	------	96	23	82	42	21	55	39	----	----	----	1.96	------	10	------	nw.	44	s.	27	17	5	9	----	0.0	0.0
Williston	1,878	41	48	27.98	29.92	−.01	67.4	+1.3	96	22	82	40	25	53	44	55	46	54	0.74	−0.6	3	5,204	se.	42	w.	28	22	8	1	2.7	0.0	0.0
Upper Mississippi Valley							**73.8**	**+1.1**										**71**	**2.76**	**−0.5**										**4.2**		
Minneapolis	918	102	208	29.02	29.99	------	72.4	+2.5	92	17	83	52	26	62	28	----	----	----	0.20	−3.5	2	7,659	s.	36	s.	18	9	16	6	4.7	0.0	0.0
St. Paul	837	236	261	29.13	30.02	+.05	71.3	+1.9	91	17	82	48	21	61	30	----	----	----	0.16	−3.3	2	8,230	s.	39	sw.	18	16	13	2	4.3	0.0	0.0
La Crosse	714	11	48	29.28	30.04	+.06	70.6	+0.6	93	29	82	48	21	59	33	----	----	----	1.40	−2.0	7	2,656	se.	17	ne.	1	13	13	5	4.4	0.0	0.0
Madison	974	70	78	29.05	30.07	+.08	70.6	+0.8	89	29	80	52	21	61	28	63	60	74	2.31	−0.9	6	4,733	s.	25	ne.	7	10	14	7	5.1	0.0	0.0
Wausau	1,247	4	------	28.76	30.08	------	67.2	------	91	29	79	42	21	56	31	----	----	----	2.27	------	9	------	se.	------	------	------	12	11	8	4.9	0.0	0.0
Charles City	1,015	10	49	29.00	30.08	+.09	70.2	+1.1	92	29	82	48	21	58	35	63	59	73	2.70	−0.7	10	3,791	se.	18	s.	22	19	7	5	3.6	0.0	0.0
Davenport	606	71	79	29.40	30.05	+.07	74.4	+1.3	94	29	85	54	21	64	30	65	61	68	3.75	+0.1	8	3,513	s.	30	ne.	19	17	10	4	3.7	0.0	0.0
Des Moines	861	84	97	29.14	30.03	+.06	73.8	+0.7	92	25	85	53	21	63	30	65	62	72	4.79	+1.2	12	3,838	s.	28	s.	17	9	14	8	5.1	0.0	0.0
Dubuque	700	81	96	29.30	30.04	+.06	72.2	+0.5	92	29	83	53	21	62	29	64	60	72	1.91	−1.1	5	3,290	s.	17	s.	18	11	13	7	4.9	0.0	0.0
Keokuk	614	64	78	29.39	30.06	+.08	75.2	+0.2	94	29	86	56	1	64	28	67	63	70	4.67	+1.4	8	3,305	se.	35	nw.	18	10	17	4	4.7	0.0	0.0
Cairo	358	87	93	29.67	30.04	+.05	79.2	+1.4	100	19	90	58	1	68	29	68	63	66	0.60	−2.3	5	3,920	s.	40	nw.	18	14	14	3	3.7	0.0	0.0
Peoria	609	11	45	29.41	30.08	+.09	73.9	+1.4	94	29	85	52	1	63	31	66	63	77	4.27	+1.3	8	2,466	se.	24	nw.	19	13	16	2	3.9	0.0	0.0
Springfield, Ill	636	10	91	29.37	30.04	+.05	75.5	+1.0	94	29	86	55	1	65	28	67	63	71	4.42	+1.6	9	3,903	w.	26	s.	10	17	9	5	3.7	0.0	0.0
Hannibal	534	74	109	29.49	30.05	+.07	75.6	+0.6	95	29	87	53	2	65	32	----	----	----	4.67	+1.3	10	4,293	sw.	26	sw.	10	17	12	2	3.3	0.0	0.0
St. Louis	568	265	303	29.45	30.04	+.05	78.3	+1.0	98	19	87	58	1	69	26	67	62	63	2.75	+0.1	8	6,436	sw.	57	sw.	12	19	10	3	3.0	0.0	0.0
Missouri Valley							**76.0**	**+2.1**										**62**	**1.82**	**−1.6**										**3.6**		
Columbia, Mo	784	11	84	29.22	30.04	+.07	75.8	+0.2	97	18	88	54	2	64	31	----	----	----	5.11	+2.1	7	3,966	se.	22	nw.	16	18	9	4	3.3	0.0	0.0
Kansas City	963	161	181	29.01	30.02	+.05	78.2	+1.6	103	18	88	59	21	68	27	67	61	60	1.65	−3.1	6	5,743	s.	29	ne.	17	19	11	1	2.8	0.0	0.0
St. Joseph	967	11	49	29.00	30.01	------	76.3	------	100	18	87	56	21	66	29	67	63	69	4.63	------	10	4,530	se.	45	nw.	16	21	8	2	2.7	0.0	0.0
Springfield, Mo	1,324	98	104	28.68	30.05	+.08	77.2	+1.5	96	18	88	54	1	67	28	65	59	60	1.74	−2.6	8	5,955	se.	39	w.	7	25	6	0	1.8	0.0	0.0
Iola	984	11	50	29.00	30.01	+.05	79.0	+2.7	103	18	93	54	1	65	34	----	----	----	0.51	−3.0	6	3,428	se.	24	se.	15	13	13	5	4.3	0.0	0.0
Topeka	987	92	107	------	------	------	78.0	+1.8	105	18	90	58	1	66	30	----	----	----	0.87	−3.4	7	5,329	s.	25	e.	16	21	8	2	2.6	0.0	0.0
Drexel	1,299	10	54	28.65	30.01	------	72.8	------	91	18	83	50	21	63	30	----	----	----	5.51	------	9	5,846	e.	32	sw.	29	17	7	4	4.4	0.0	0.0
Lincoln	1,189	11	84	28.77	30.00	+.05	75.3	+0.9	94	29	86	53	21	65	30	66	62	68	4.86	+1.2	10	5,961	se.	32	nw.	14	11	13	7	4.5	0.0	0.0
Omaha	1,105	115	122	28.86	30.01	+.05	75.5	+1.1	94	18	85	56	21	66	25	66	62	67	2.70	−0.9	8	4,632	se.	30	nw.	19	18	6	4	3.8	0.0	0.0
Valentine	2,598	47	54	27.32	29.98	+.04	73.4	+1.7	103	22	86	49	1	60	40	61	55	61	1.42	−1.4	11	6,501	s.	38	s.	23	14	9	8	4.3	0.0	0.0
Sioux City	1,135	94	164	28.83	30.01	+.06	73.6	+1.6	91	4	84	49	21	63	33	64	58	64	0.71	−2.3	5	7,980	s.	43	e.	16	17	8	6	4.2	0.0	0.0
Huron	1,306	59	74	28.62	29.98	+.03	74.7	+5.3	104	23	89	47	21	60	41	61	54	55	0.42	−2.2	9	7,099	s.	38	sw.	15	17	11	3	3.4	0.0	0.0
Pierre	1,572	70	75	28.31	29.94	.00	76.2	+3.4	105	22	90	52	1	62	41	62	54	52	1.03	−1.0	6	6,356	se.	42	w.	14	17	10	4	3.8	0.0	0.0
Yankton	1,233	49	57	28.70	29.98	+.03	75.1	+3.1	96	23	87	51	21	64	37	----	----	----	0.83	−2.3	7	5,445	nw.	31	s.	23	12	15	4	4.4	0.0	0.0

TABLE 1.—*Climatological data for Weather Bureau stations, August, 1925*—Continued

Districts and stations	Elevation of instruments			Pressure			Temperature of the air									Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation			Wind					Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Barometer above sea level	Thermometer above ground	Anemometer above ground	Station, reduced to mean of 24 hours	Sea level, reduced to mean of 24 hours	Departure from normal	Mean max. + mean min. ÷ 2	Departure from normal	Maximum	Date	Mean maximum	Minimum	Date	Mean minimum	Greatest daily range				Total	Departure from normal	Days with 0.01, or more	Total movement	Prevailing direction	Maximum velocity: Miles per hour	Maximum velocity: Direction	Maximum velocity: Date						
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	F. °F.	°F.		°F	°F.		°F	°F.	°F.	%	In.	In.	In.		Miles								0–10	In.	In.
Northern Slope							**66.4**	**+0.1**										**54**	**1.43**	**+0.2**										**3.8**		
Billings	3,140	5					67.2		95	3	86	36	16	48	50				0.32		4		nw.				22	5	4		0.0	0.0
Havre	2,505	11	44	27.34	29.93	+.02	65.7	+0.7	96	2	81	40	30	50	48	54	46	58	1.78	+0.5	9	3,356	sw.	36	sw.	27	20	8	3	3.1	0.0	0.0
Helena	4,110	87	112	25.83	29.95	+.01	65.0	0.0	91	2	79	41	25	52	42	50	39	44	1.15	+0.5	6	5,957	sw.	37	sw.	26	14	10	7	4.3	0.0	0.0
Kalispell	2,973	48	56	26.92	29.93	.00	61.8	−1.0	89	1	75	37	25	48	40	50	41	54	1.12	+0.2	7	4,270	nw.	21	nw.	21	20	6	5	3.7	0.0	0.0
Miles City	2,371	48	55	27.46	29.96	+.03	71.8	+0.3	99	22	86	47	30	58	39	57	47	50	1.68	+0.6	4	3,697	se.	44	nw.	28	22	9	0	2.1	0.0	0.0
Rapid City	3,259	50	58	26.64	29.98	+.05	71.4	+1.9	98	22	85	47	25	58	37	57	47	48	2.30	+0.2	6	5,040	se.	28	n.	7	11	16	4	4.2	0.0	0.0
Cheyenne	6,088	84	101	24.14	29.98	+.06	64.0	−1.6	85	22	75	46	13	53	33	53	46	60	1.13	−0.3	13	6,933	s.	40	w.	29	12	7	12	5.4	0.0	0.0
Lander	5,372	60	68	24.73	29.96	+.04	65.9	+0.4	88	31	80	43	16	51	39	52	41	48	0.29	−0.2	9	4,315	sw.	34	w.	5	12	18	1	4.4	0.0	0.0
Sheridan	3,790	10	47	26.14	29.97		66.6		99	22	85	37	16	49	51	53	43	52	T.		0	3,148	s.	30	nw.	27	17	14	0	3.2	0.0	0.0
Yellowstone Park	6,241	11	48	23.99	30.02	+.09	57.8	−3.1	82	1	72	33	25	43	42	47	41	61	1.65	+0.6	11	5,510	s.	37	sw.	15	9	18	4	4.6	0.0	0.0
North Platte	2,821	11	51	27.14	30.02	+.08	73.9	+3.1	95	24	87	49	1	61	36	62	57	66	1.75	−0.7	9	5,039	s.	28	nw.	14	22	5	4	2.9	0.0	0.0
Middle Slope							**75.9**	**−0.1**										**60**	**2.44**	**0.0**										**3.7**		
Denver	5,292	106	113	24.84	30.00	+.08	69.6	−1.1	90	23	80	52	1	59	33	56	48	57	1.68	+0.3	17	5,041	s.	35	n.	12	14	12	5	4.6	0.0	0.0
Pueblo	4,685	80	86	25.38	29.98	+.07	71.6	−1.1	95	17	85	52	1	58	40	58	51	58	1.42	−0.2	8	3,725	nw.	28	w.	5	12	18	1	4.3	0.0	0.0
Concordia	1,392	50	58	28.54	29.98	+.03	77.2	+0.7	100	18	88	55	21	66	31	66	60	63	4.10	+1.3	11	4,831	s.	33	se.	15	17	10	4	3.9	0.0	0.0
Dodge City	2,509	11	51	27.47	30.01	+.08	76.0	−1.7	99	17	88	53	1	64	32	64	59	64	3.09	+0.5	9	6,549	se.	27	s.	29	24	5	2	2.2	0.0	0.0
Wichita	1,358	139	158	28.59	29.98	+.03	79.6	+1.3	101	18	91	60	1	69	31	66	60	58	2.52	−0.6	7	8,196	s.	39	s.	6	13	15	3	3.6	0.0	0.0
Broken Arrow	765	11	56	29.22	30.03		80.9		102	19	93	60	1	68	31				0.30		5	7,267	s.	48	s.	10	17	7	7	3.8	0.0	0.0
Oklahoma City	1,214	10	47	28.75	30.00	+.06	81.2	+1.5	102	18	92	59	1	70	29	68	62	59	1.83	−1.3	4	5,857	s.	25	nw.	13	14	15	2	3.5	0.0	0.0
Southern Slope							**78.4**	**−1.2**										**65**	**1.94**	**−0.4**										**3.9**		
Abilene	1,738	10	52	28.22	29.98	+.06	81.1	−0.9	101	22	92	56	2	70	29	68	62	63	1.36	−0.6	8	5,402	s.	31	sw.	10	14	9	8	4.5	0.0	0.0
Amarillo	3,676	10	49	26.36	30.02	+.10	74.8	−0.9	95	17	86	55	1	64	30	64	60	68	3.19	+0.4	10	6,806	s.	30	ne.	3	15	10	6	3.9	0.0	0.0
Del Rio	944	64	71	29.00	29.96	+.06	83.5	−0.5	99	21	93	65	1	74	24				1.62	−0.9	5	6,174	se.	44	w.	9	20	7	4	3.3	0.0	0.0
Roswell	3,566	75	85	26.42	29.96	+.08	74.4	−2.2	94	15	86	55	2	63	30	63	58	64	1.58	−0.4	7	4,628	s.	30	e.	4	15	13	3	4.0	0.0	0.0
Southern Plateau							**76.0**	**−1.4**										**54**	**0.94**	**−0.2**										**2.9**		
El Paso	3,778	152	175	26.23	29.92	+.08	77.8	−1.4	96	13	88	58	2	67	28	63	55	53	2.16	+0.4	10	6,006	se.	43	e.	25	16	15	0	3.7	0.0	0.0
Santa Fe	7,013	38	53	23.40	29.94	+.05	65.6	−1.8	84	19	77	45	27	54	29	53	46	56	1.41	−1.0	16	3,931	se.	24	se.	25	13	14	4	4.5	0.0	0.0
Flagstaff	6,907	10	59	23.49	29.94	+.10	61.7	−1.1	83	21	75	43	16	48	37	50		64	2.49		17	5,004	w.	26	w.	11	9	17	5		0.0	0.0
Pheonix	1,108	10	82	28.71	29.83	+.04	87.2	−1.3	107	19	100	69	14	74	36	70	62	47	0.61	−0.4	6	3,479	e.	30	ne.	5	21	7	3	3.0	0.0	0.0
Yuma	141	9	54	29.66	29.80	+.04	90.2	−0.2	111	19	104	69	15	76	39	72	64	48	0.23	−0.1	3	3,973	s.	35	e.	26	29	2	0	0.9	0.0	0.0
Independence	3,957	5	25				73.6	−2.5	99	4	91	44	23	56	44	53			0.31	+0.2	2		se.				17	7	7	2.5	0.0	0.0
Middle Plateau							**69.0**	**−2.1**										**45**	**1.55**	**+0.7**										**3.9**		
Reno	4,532	74	81	25.40	29.92	+.08	67.1	+.01	96	6	83	38	24	51	44	51	41	47	0.28	0.0	7	4,931	w.	36	w.	7	22	4	5	2.8	0.0	0.0
Tonopah	6,090	12	20				69.0		86	4	80	49	23	58	26	51	36	36	1.29		5		se.								0.0	0.0
Winnemucca	4,344	18	56	25.63	29.96	+.08	66.6	−2.7	95	6	84	37	24	49	49	50	38	46	0.79	+0.6	5	4,206	sw.	28	se.	1	18	7	6	3.3	0.0	0.0
Modena	5,479	10	43	24.68	29.94	+.08	66.1	−3.1	88	4	81	42	29	51	40	52	41	50	2.64	+0.8	14	7,634	sw.	48	nw.	5	16	10	5	3.8	0.0	0.0
Salt Lake City	4,360	163	203	25.64	29.92	+.01	73.0	−1.5	92	1	84	53	24	62	30	56	44	41	1.83	+1.0	9	5,193	se.	40	se.	9	18	5	8	3.9	0.0	0.0
Grand Junction	4,602	60	68	25.44	29.97	+.07	72.2	−3.2	93	7	84	54	12	61	33	57	48	50	2.20	+1.2	13	4,440	se.	34	s.	23	7	13	11	5.8	0.0	0.0
Northern Plateau							**69.9**	**0.0**										**44**	**0.72**	**+0.3**										**3.6**		
Baker	3,471	48	53	26.46	29.98	+.03	64.4	−0.2	92	20	80	35	24	49	43	51	40	49	1.13	+0.7	5	4,100	se.	30	sw.	1	12	11	8	4.6	0.0	0.0
Boise	2,739	78	86	27.14	29.94	+.01	70.8	−1.0	99	1	85	40	24	56	41	55	42	42	0.28	+0.1	3	3,454	se.	31	w.	13	20	8	3	2.7	0.0	0.0
Lewiston	757	40	48	29.12	29.92	−.03	73.8	+1.0	107	20	89	49	30	58	47				1.30	+0.9	6	2,232	e.	24	nw.	21	17	10	4	3.5	0.0	0.0
Pocatello	4,477	60	68	25.50	29.94	+.02	67.5	−2.1	91	8	82	38	25	53	49	52	40	46	0.89	+0.3	9	5,584	se.	30	sw.	13	14	8	9	4.5	0.0	0.0
Spokane	1,929	101	110	27.92	29.93	−.02	69.4	+1.3	99	20	83	43	30	56	42	54	41	42	0.20	−0.3	4	4,162	s.	22	sw.	21	16	9	6	3.8	0.0	0.0
Walla Walla	991	57	65	28.87	29.92	−.04	73.6	+0.9	99	1	86	49	29	61	39	56	43	39	0.51	+0.1	5	3,497	s.	21	sw.	14	20	9	2	2.4	0.0	0.0
North Pacific Coast Region							**62.1**	**−0.1**										**72**	**1.23**	**+0.4**										**5.0**		
North Head	211	11	56	29.85	30.07	+.04	57.8	+0.2	74	8	61	51	7	54	19	55	54	89	1.42	+0.9	13	9,548	n.	36	n.	3	4	11	16	7.2	0.0	0.0
Port Angeles	29	8	53		30.06		60.0		92	8	68	44	29	51	35				0.39	−0.3	5	5,207	sw.	28	nw.	14	14	10	7		0.0	0.0
Seattle	125	215	250	29.93	30.06	+.06	62.6	−0.5	84	8	71	48	29	55	25	56	52	70	1.31	+0.8	6	5,147	s.	28	s.	21	12	9	10	4.8	0.0	0.0
Tacoma	194	172	201	29.84	30.04	+.02	63.1	+0.5	82	8	72	49	29	55	25				0.46	−0.3	4	5,475	n.	28	s.	21	6	13	12	6.2	0.0	0.0
Tatoosh Island	86	9	53	29.95	30.05	+.05	55.8	+0.5	76	8	60	49	7	52	25	54	53	94	3.50	+1.4	8	7,882	sw.	37	s.	25	1	17	13	6.9	0.0	0.0
Yakima	1,071	5					70.4		101	1	89	36	24	52	52				T.		0		nw.				22	7	2	2.8	0.0	0.0
Medford	1,425	4					70.3		104	8	89	40	24	51	47	55	45	50	0.29		2		nw.	15	nw.	31	18	7	6		0.0	0.0
Portland, Oreg.	153	68	106	29.86	30.02	+.01	66.0	−0.7	96	8	76	47	27	56	33	59	54	68	0.71	+0.1	8	3,882	nw.	18	nw.	7	13	7	11	4.6	0.0	0.0
Roseburg	510	9	57	29.47	30.01	+.01	67.4	−0.6	98	8	83	44	24	52	40	57	50	61	0.85	+0.5	1	2,578	n.	17	n.	6	23	6	2	2.3	0.0	0.0
Middle Pacific Coast Region							**64.2**	**−0.6**										**69**	**0.09**	**+0.1**										**3.7**		
Eureka	62	73	89	29.98	30.05	+.05	56.2	+0.2	66	22	60	49	15	52	15	54	52	88	0.25	+0.2	2	4,087	nw.	26	n.	23	7	11	13	5.9	0.0	0.0
Point Reyes	490	7	18	29.43	29.95		55.0	+0.5	67	22	59	47	5	51	14				T.		0	10,980	nw.	42	nw.	27	4	8	19	7.5	0.0	0.0
Red Bluff	332	50	56	29.54	29.89	+.03	76.2	−3.5	104	4	91	52	19	61	41	60	49	44	0.20	+0.2	2	3,977	se.	19	se.	22	28	3	0	1.1	0.0	0.0
Sacramento	69	106	117	29.84	29.91	+.06	71.0	−1.9	97	4	85	53	28	57	41	59	51	62	0.01	0.0	1	6,872	s.	25	s.	17	29	1	1	1.0	0.0	0.0
San Francisco	155	208	243	29.81	29.98	+.06	61.2	+2.1	84	25	67	51	5	55	27	56	53	81	T.	0.0	0	7,376	w.	34	w.	3	9	20	2	4.8	0.0	0.0
San Jose	141	12	110	29.82	29.98		65.9	−0.8	92	25	79	48	18	53	42				0.00	0.0	0	4,696	nw.	20	nw.	23	24	7	0	2.0	0.0	0.0
South Pacific Coast Region							**70.4**	**−1.0**										**67**	**0.01**	**0.0**										**2.0**		
Fresno	327	89	98	29.52	29.86	+.04	78.6	−2.1	104	5	95	56	17	63	38	60	46	39	T.	0.0	0	5,510	nw.	21	nw.	10	28	3	0	0.8	0.0	0.0
Los Angeles	338	159	191	29.58	29.94	+.06	69.9	−1.2	86	19	79	58	31	60	25	62	58	74	0.00	0.0	0	3,732	sw.	15	w.	18	25	5	1	2.1	0.0	0.0
San Diego	87	62	70	29.84	29.93	+.04	68.8	+0.1	78	22	74	61	21	64	15	64	62	81	0.01	0.0	1	4,726	w.	19	nw.	19	24	5	2	2.7	0.0	0.0
San Luis Obispo	201	32	40	29.78	29.99	+.05	64.2	−0.9	91	24	76	48	29	53	34	56	52	73	0.03	0.0	1	2,856	nw.	17	nw.	22	23	8	0	2.4	0.0	0.0
West Indies																																
San Juan, P. R.	82	9	54	29.90	29.99		80.6	+0.1	89	4	86	73	15	76	14				4.48	−2.9	17	9,986	e.	33	e.	25	9	17	5	5.1	0.0	0.0
Panama Canal																																
Balboa Heights	118	7	97		29.82	−.02	80.6	+0.5	92	30	87	72	9	74	18				10.83	+3.0	16	4,744	nw.	36	n.	20	0	17	14		0.0	0.0
Colon	36	7	97		29.83	−.03	81.5	+1.4	91	30	87	74	3	76	15				7.71	−7.2	17	6,920	n.	25	n.	29	2	7	22		0.0	0.0
Alaska																																
Juneau	80	11	54				55.0		70	25	61	44	23	49	24	52	50	86	7.72		20	3,372	s.	24	se.	29	4	2	25	8.6	0.0	0.0
Hawaiian Islands																																
Honolulu	38	86	100				78.6		86	24	83	70	11	74	15	70	66	69	0.18	−1.1	9	8,175	e.	35	e.	3	17	13	1	3.6	0.0	0.0

TABLE 2.—*Data furnished by the Canadian Meteorological Service, August, 1925*

Station	Altitude above mean sea level, Jan. 1, 1919	Pressure			Temperature of the air						Precipitation		
		Station reduced to mean of 24 hours	Sea level reduced to mean of 24 hours	Departure from normal	Mean max.+mean min.÷2	Departure from normal	Mean maximum	Mean minimum	Highest	Lowest	Total	Departure from normal	Total snowfall
	Feet	*Inches*	*Inches*	*Inches*	*°F.*	*°F.*	*°F.*	*°F.*	*°F.*	*°F.*	*Inches*	*Inches*	*Inches*
St. Johns, N. F	125												
Sydney, C. B. I	48												
Halifax, N. S	88												
Yarmouth, N. S	65												
Charlottetown, P. E. I	38												
Chatham, N. B	28												
Father Point, Que	20	29.91	29.93	+.02	56.4	+0.8	63.1	49.7	75	44	1.70	−1.35	0.0
Quebec, Que	296	29.70	30.02	+.09	66.1	+3.0	75.2	57.0	83	45	3.10	−0.73	0.0
Montreal, Que	187	29.81	30.01	+.06	69.6	+3.2	78.8	60.4	88	46	1.02	−2.55	0.0
Stonecliff, Ont	489												
Ottawa, Ont	236	29.78	30.04	+.08	68.6	+3.8	80.6	56.7	92	43	0.94	−2.09	0.0
Kingston, Ont	285	29.76	30.07	+.09	68.1	+1.1	75.5	60.7	85	48	4.94	+2.56	0.0
Toronto, Ont	379	29.66	30.05	+.06	68.8	+2.8	79.2	58.3	88	48	2.48	−0.28	0.0
Cochrane, Ont	930				62.2		74.7	49.8	86	32	2.08		0.0
White River, Ont	1,244	28.72	30.01	+.05	60.4	+4.0	74.4	46.4	85	28	1.87	−1.43	0.0
Port Stanley, Ont	592												
Southampton, Ont	656	29.37			66.3	+2.5	76.9	55.7	93	42	0.34	−1.91	0.0
Parry Sound, Ont	688	29.38	30.06	+.08	67.5	+4.0	79.9	55.1	92	41	0.77	−1.95	0.0
Port Arthur, Ont	644	29.32	30.03	+.07	63.9	+4.4	72.4	55.3	80	40	2.63	−0.12	0.0
Winnipeg, Man	760												
Minnedosa, Man	1,690	28.16	29.94	.00	62.7	+3.3	75.4	49.9	89	35	1.26	−0.84	0.0
Le Pas, Man	860				61.5		72.0	51.0	91	40	2.05		0.0
Qu'Appelle, Sask	2,115	27.70	29.91	−.02	63.7	+2.2	78.1	49.3	92	36	0.70	−0.94	0.0
Medicine Hat, Alb	2,144	27.60	29.82	−.10	65.5	−0.2	79.8	51.3	97	40	1.47	−0.20	0.0
Moose Jaw, Sask	1,759				65.2		81.7	48.8	99	37	0.81		0.0
Swift Current, Sask	2,392	27.42	29.89	−.04	64.1	+0.1	79.5	48.7	94	39	1.79	−0.12	0.0
Calgary, Alb	3,428	26.41	29.92	+.01	58.5	−0.9	73.2	43.9	91	31	1.61	−0.53	0.0
Banff, Alb	4,521	25.42	29.93	+.02	54.6	−1.7	68.8	40.4	85	29	2.85	+0.32	0.0
Edmonton, Alb	2,150	27.62	29.86	−.06	58.3	−0.5	69.6	47.1	90	31	2.61	+0.48	0.0
Prince Albert, Sask	1,450	28.37	29.92	.00	62.3	+3.4	74.4	50.2	93	38	3.64	+1.49	0.0
Battleford, Sask	1,592	28.21	29.93	+.02	61.8	−0.8	74.1	49.6	94	38	3.06	+0.70	0.0
Kamloops, B. C	1,262												
Victoria, B. C	230	29.77	30.02	+.01	60.7	+2.0	68.4	53.0	82	47	0.37	−0.23	0.0
Barkerville, B. C	4,180												
Triangle Island, B. C	680												
Prince Rupert, B. C	170												
Hamilton, Ber	151	29.96	30.12	+.02	78.1	−1.5	83.9	72.3	88	68	7.28	+1.20	0.0

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Charlottetown, P. E. I	38	29.83	29.87	−.03	65.3	+1.2	71.8	58.7	81	48	1.36	−2.13	0.0
Sydney, C. B. I	48	29.88	29.93	.00	63.2	+0.9	74.2	52.1	85	42	1.42	−2.23	0.0
Halifax, N. S	88	29.82	29.92	−.04	64.6	+1.2	74.3	55.0	84	43	1.81	−2.24	0.0
Yarmouth, N. S	65	29.81	29.88	−.07	60.3	+0.8	67.4	53.2	78	45	4.26	+0.64	0.0
Chatham, N. B	28	29.76	29.79	−.09	64.4	−0.6	74.7	54.1	83	41	4.62	+0.43	0.0
Calgary, Alb	3,428	26.48	30.00	+.10	62.2	+1.6	76.9	47.5	93	39	2.00	−0.68	0.0
Banff, Alb	4,521	25.48	29.98	+.08	59.8	+3.2	76.2	43.3	87	33	1.49	−1.75	0.0
Kamloops, B. C	1,262	28.70	29.96	+.02	72.4	+3.9	86.3	58.4	95	49	0.41	−1.20	0.0
Barkerville, B. C	4,180	25.75	30.03	+.12	54.3	−0.8	67.7	40.9	77	34	2.90	−0.12	0.0
Winnipeg, Man	760	29.13	29.94	+.01	66.6	+0.6	78.3	54.9	93	45	0.61	−2.47	0.0

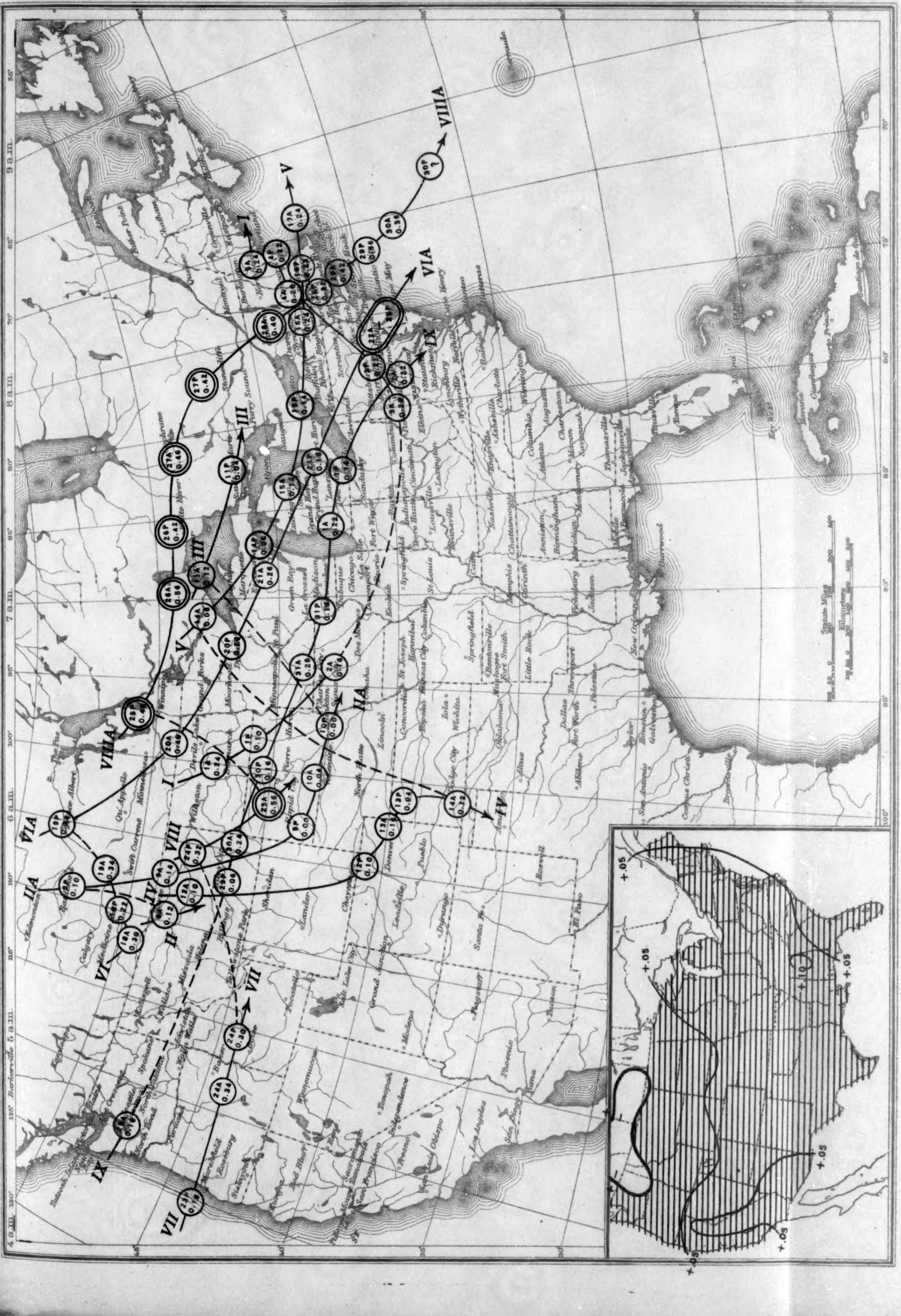


Chart I. Tracks of Centers of Anticyclones, August, 1925. (Inset) Departure of Monthly Mean Pressure from Normal

(Plotted by Wilfred P. Day)

Chart II. Tracks of Centers of Cyclones, August, 1925. (Inset) Change in Mean Pressure from Preceding Month

(Plotted by Wilfred P. Day)

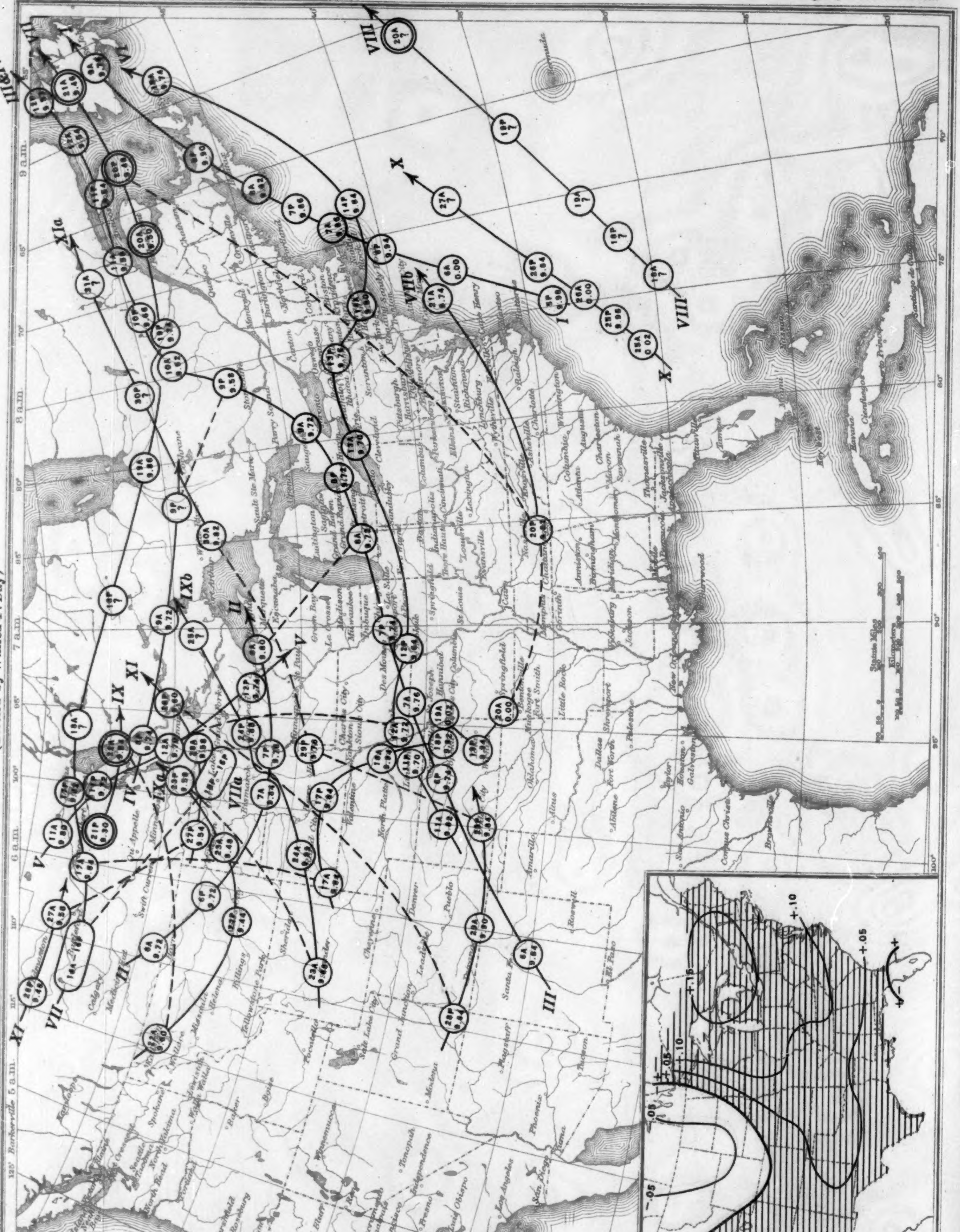
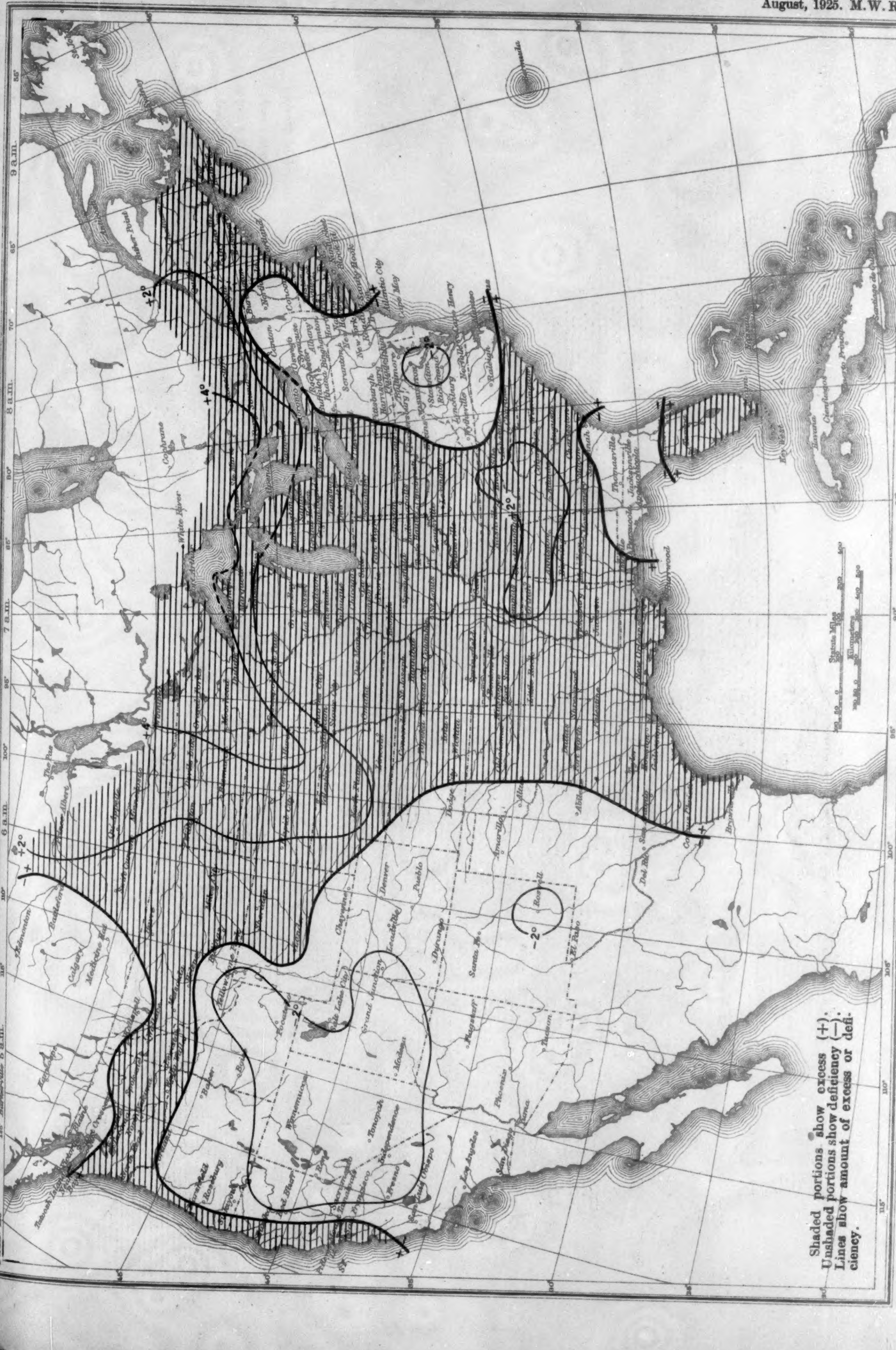


Chart III. Departure (°F.) of the Mean Temperature from the Normal, August, 1925

Chart III. Departure (°F.) of the Mean Temperature from the Normal, August, 1925



Shaded portions show excess (+). Unshaded portions show deficiency (−). Lines show amount of excess or deficiency.

Chart IV. Total Precipitation, Inches, August, 1925. (Inset) Departure of Precipitation from Normal

Chart V. Percentage of Clear Sky between Sunrise and Sunset, August, 1925

Chart VI. Isobars at Sea level and Isotherms at Surface; Prevailing Winds, August, 1925

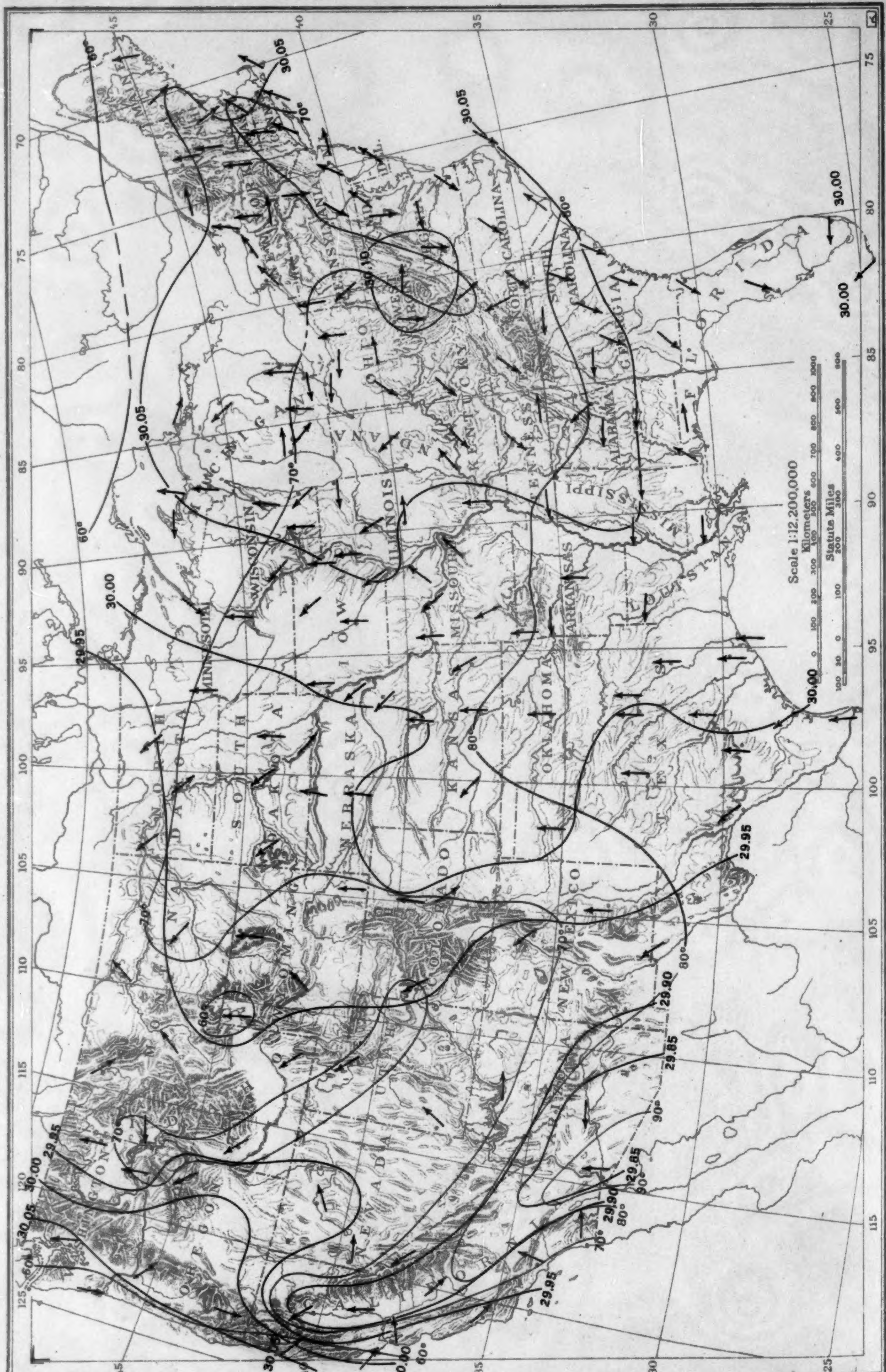


Chart VIII. Weather Map of North Atlantic Ocean, August 20, 1925

(Plotted by F. A. Young)

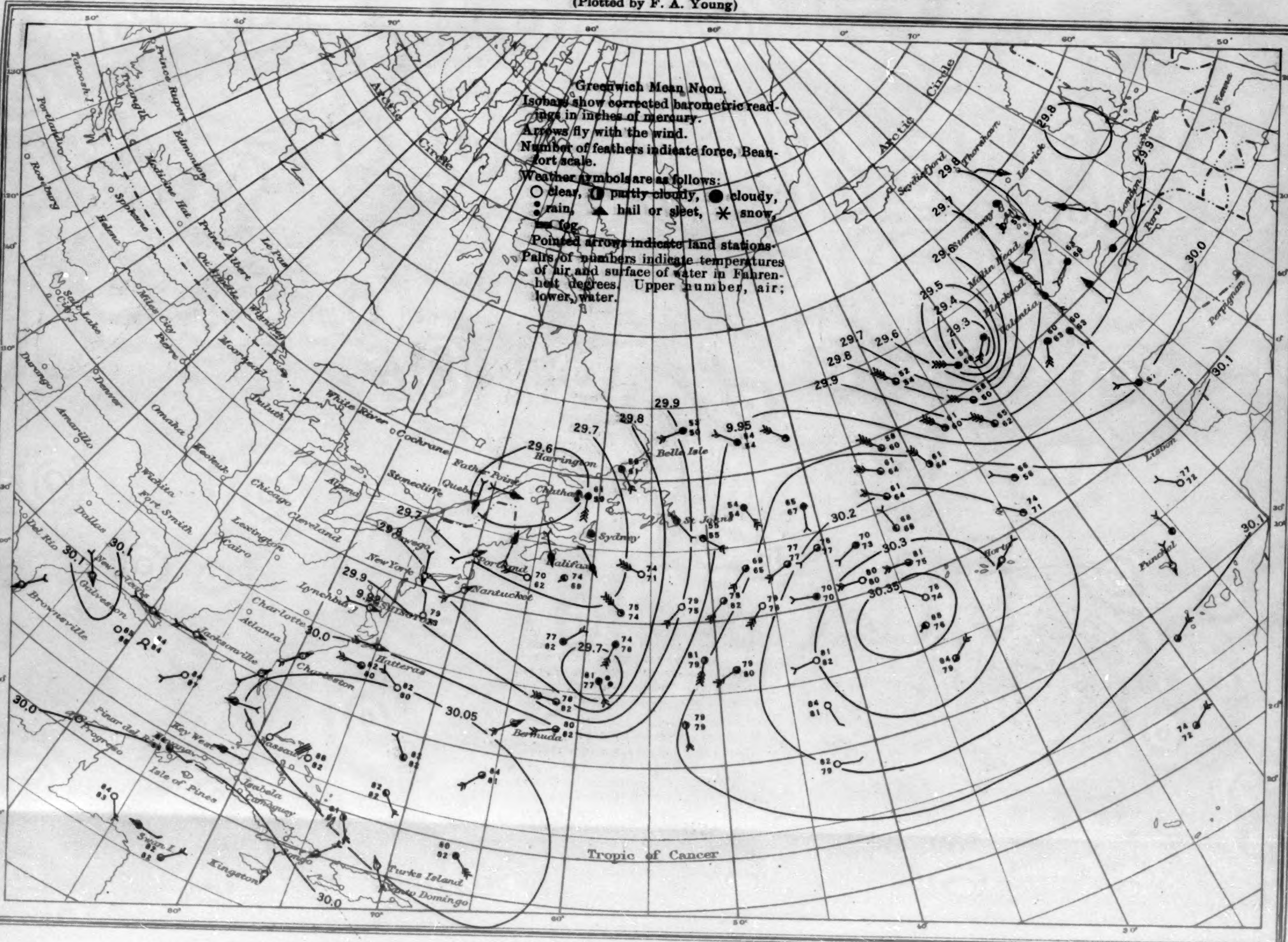


Chart IX. Weather Map of North Atlantic Ocean, August 21, 1925

(Plotted by F. A. Young)

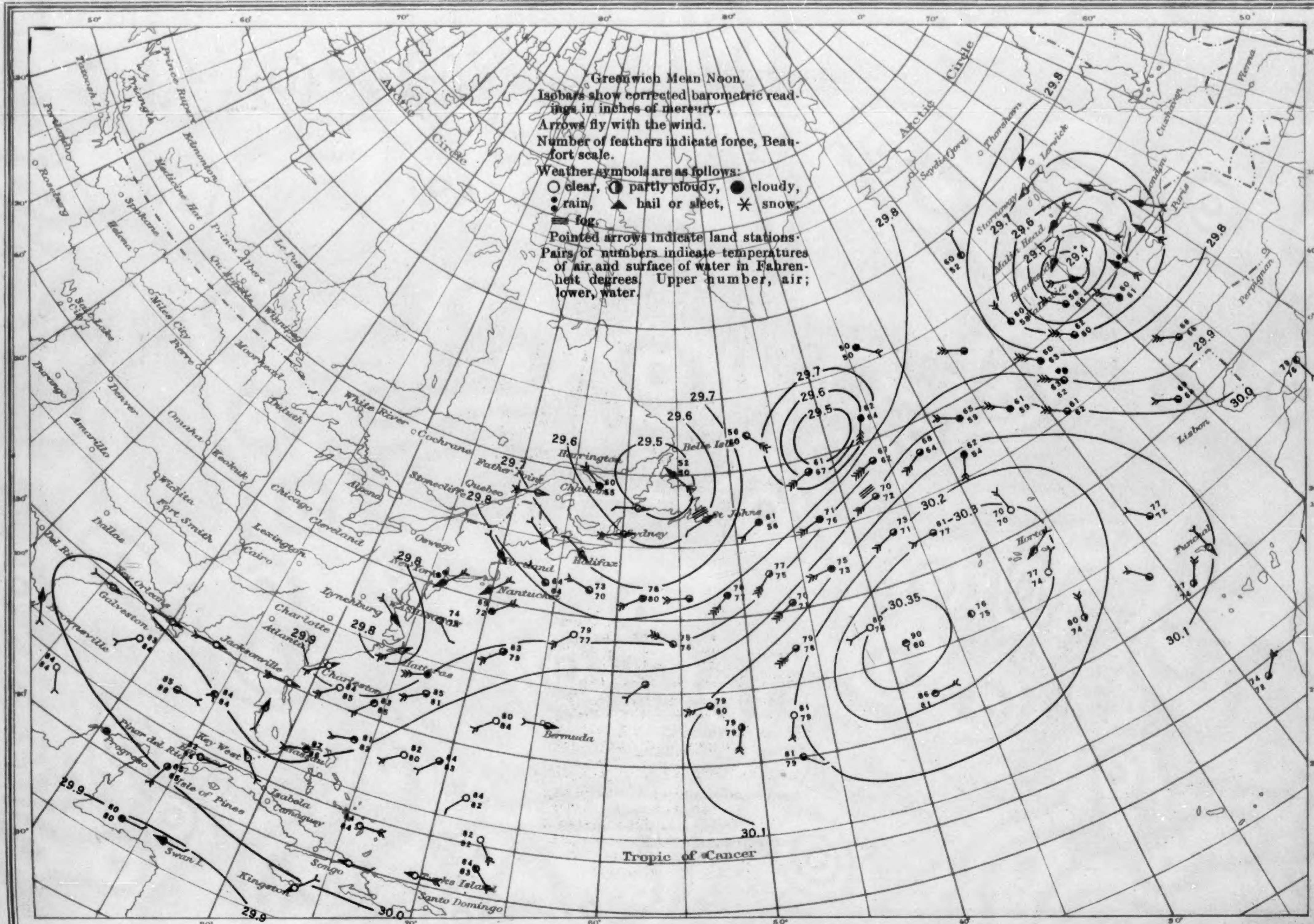


Chart X. Weather Map of North Atlantic Ocean, August 22, 1925

(Plotted by F. A. Young)

Chart X. Weather Map of North Atlantic Ocean, August 22, 1925
(Plotted by F. A. Young)

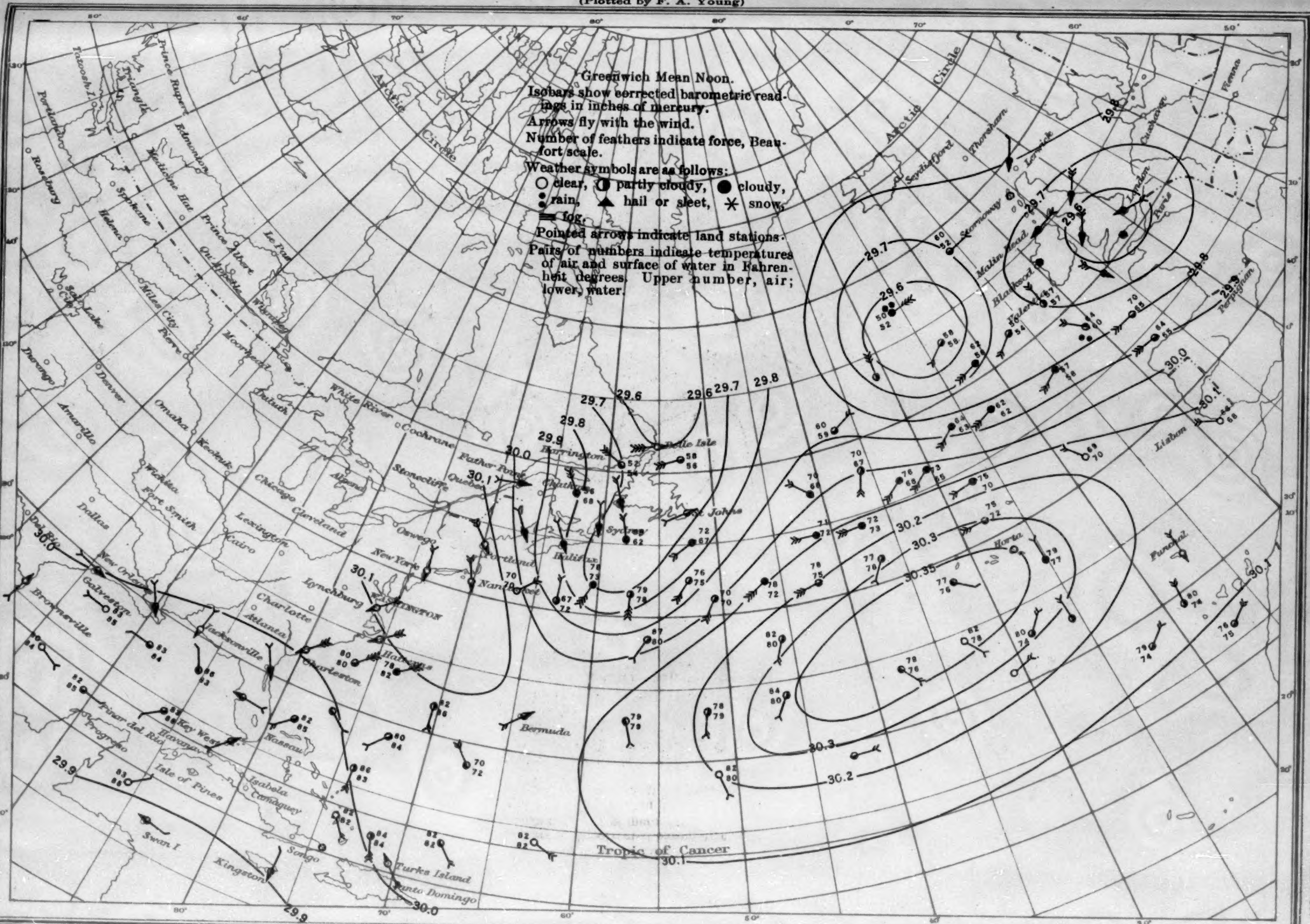


Chart XI. Weather Map of North Atlantic Ocean, August 23, 1925

(Plotted by F. A. Young)